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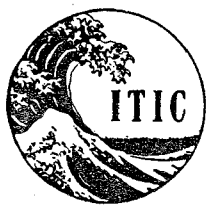

INTERNATIONAL
TSUNAMI
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CENTER

INTERGOVERNMENTAL
OCEANOGRAPHIC
COMMISSION - UNESCO

INTERNATIONAL TSUNAMI INFORMATION CENTER

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TSUNAMI NEWSLETTER is published by the International Tsunami Information Center to bring news and information to scientists, engineers, educators, community protection agencies and governments throughout the world.

We welcome contributions from our readers.

The International Tsunami Information Center is maintained by the U.S. National Oceanic and Atmospheric Administration for the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization. The Center's mission is to mitigate the effects of tsunamis throughout the Pacific.

MEMBER STATES

Present membership of the International Coordination Group for the Tsunami Warning System in the Pacific comprises of the following States:

CANADA
CHILE
COLOMBIA
COOK ISLANDS
ECUADOR
FIJI
FRANCE
GUATEMALA
INDONESIA
JAPAN
KOREA (REPUBLIC OF)
MEXICO
NEW ZEALAND
PERU
PHILIPPINES
SINGAPORE
THAILAND
UNITED KINGDOM (HONG KONG)
USA
USSR
WESTERN SAMOA

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Is There a Seasonal Dependence in Tsunami Data?

T.S. Murty
Institute of Ocean Sciences
Dept. of Fisheries and Oceans
Sidney, Canada

Introduction

There are certain geophysical phenomena which have obviously a seasonal (and monthly) dependence: e.g. air temperature, recipitation, frequency of cyclones etc. Usually earthquakes and tsunamis are considered a random phenomenon and one does not associate any seasonal or monthly dependence. In fact, it would be difficult to account for a seasonal dependence, were it to exist.

While examining tsunami data for the Pacific Ocean, it appeared to us that there might be a monthly dependence. Our data source is the catalogue prepared by Iida et al (1967) which covers the period 83 to 1967. This list includes major as well as minor tsunamis that are definitely established, that probably occurred and those that were reported as tsunamis but really were storm surges and other events. For this study we only considered those that were verified.

Tsunamis in the Pacific Ocean

Table 1 lists the number of tsunamis for the whole Pacific Ocean by month for the entire period 83 to 1967 inclusive. In preparing this table we used the criterion that if a tsunami started in a given month X and continued into the next month Y (say, the tsunami started at 2300 hours on March 31 and continued until 0200 hours on April 1, then it is assigned to March), then it is assigned to the month X. Out of a total of 322 cases, there were only a few that needed to be assigned in the above manner.

The monthly average of Pacific Ocean tsunamis, based on data in Table 1 is 26.8. We asked the question whether the differences from the observed monthly average are significant. The months of November, August and March showed unusually high number of tsunamis, whereas the months of July and April showed unusually low numbers of events. We applied the standard Chi-square test to this data which showed that the observed results are significant at the 97.5% confidence limit. In other words, the chance of obtaining the distribution shown in Table 1, purely by chance (i.e. a random process) is only once in forty trials. This result suggests (but does not prove) that there may be monthly dependence in tsunami data. In any case, one cannot totally rule out the possibility that tsunamis in the Pacific Ocean may have monthly dependence.

TABLE 1

Total number of tsunamis

in the Pacific Ocean

for the Period B3 to 1967

(based on Iida et al. 1967)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of Tsunamis	23	22	36	19	24	27	16	38	27	24	39	27

References

Iida, K., D.C. Cox and G. Pararas-Carayannis (1967) Preliminary Catalog of Tsunamis occurring in the Pacific Ocean, University of Hawaii, Institute of Geophysics, Data Report, HIG-67-10.

INTERNATIONAL TSUNAMI INFORMATION CENTER

Scientists from Chile and China Visits ITIC

Mr. Emilio Lorca of Chile and Mr. Qing-Hai Zhou of the People's Republic of China have recently completed a 6-week training visit to ITIC and PTWC under the Visiting Expert Program sponsored by UNESCO-IOC.

Mr. Emilio Lorca, Chile

Mr. Qing-Hai Zhou. China

Mr. Lorca is in charge of the Chilean Tsunami Warning System. During his visit, he worked closely with PTWC on the operational procedures and techniques used for tsunami preparedness. He also worked with the Director of ITIC on the Standard Operational Plan for the Tsunami Hazard Reduction Utilizing System Technology (THRUST) project.

Mr. Zhou is the Assistant Engineer of the National Marine Environmental Forecasting Center of People's Republic of China. During his stay, he familized himself with the Pacific Tsunami Warning System, and with the operational techniques being used for tsunami monitoring and evaluation. The experience gained by Mr. Zhou during this visit will be extremely helpful in assisting with the establishment of a regional tsunami warning system in the People's Republic of China.

Visitors to ITIC

George Curtis	Joint Institute of Marine and Atmospheric Research, Univ. of Hawaii
Charles Mader	Los Alamos National Lab., New Mexico
Narendra Saxena	University of Hawaii, Honolulu, Hawaii
Elinor DeWire	Free lance writer, Honolulu, Hawaii
Yang Zhuang Sheng	Beijing, People's Republic of China
William Richardson	Wang Laboratory, Honolulu, Hawaii
Falconer Henry	Institute of Ocean Sciences, Victoria, Canada
Robert S.	World Meteorological Organization, Perth, Australia
Carolyn Hodge	National Weather Service, Silver Spring Maryland
Gloria Walker	National Weather Service, Silver Spring Maryland
Daryl Doty	Wang Laboratory, Honolulu, Hawaii
Emilio Lorca	Instituto Hidrografico en la Armada, Valparaiso, Chile
Zhou, Qing-Hai	National Marine Environmental Forecasting Center, Beijing, China
Ernesto Navano	First Family of Travel, Inc. Honolulu, Hawaii
Sharon Lundin	Western Administrative Support Center, Seattle, Washington
Bernie Kilonsky	Dept. of Oceanography, Univ. of Hawaii

UNESCO - IOC - ITSU

The following include national reports presented at ITSU-IX in March, 1984 in Honolulu, Hawaii as well as reports received after the meeting.

ITSU-IX NATIONAL REPORTS

CANADA

International Tsunami Warning System

Canada maintains two tide stations in the International Tsunami Warning System, at Tofino and Langara. Both can be interrogated by telephone, and the station at Tofino is automated to provide voice transmission of water levels directly from the tide gauge.

In the past two years the network of seismic stations on Canada's Pacific coast has been extended by the Seismological Service of Canada. Digital data from these stations are telemetered into the Pacific Geoscience Centre at Sidney, B.C., and information from these seismic network is available to the Tsunami Warning Centers on request.

A major change in warning system procedures has been made since 1982, with the Alaska Tsunami Warning Center (ATWC) providing regional tsunami watch and warning messages to Canada, as well as Alaska and mainland United States. The services of ATWC and PTWC are complementary and the change provides the benefit of the earliest available warning of an impending tsunami.

Master Plan for the Tsunami Warning System

In accordance with Resolution of ITSU-VIII Canada has taken a lead role in the development of the Master Plan. The draft being presented at this meeting by Mr. Dohler was published in Ottawa subsequent to the completion of his year of service as Associate Director of ITIC.

We commend the work carried out to this date, and recognize the importance of ITSU acting to bring the plan to completion.

A set of 42 chartlets has been prepared as a Canadian contribution to the development of the Master Plan. Copies of these chartlets can be supplied on request, and Member States are encouraged to designate on copies of these chartlets the high risk zones in their respective states.

These chartlets are on the standard scale of 1:10,000,000 and have been prepared with the GEBCO chart series of International Hydrographic Bureau as a reference. An index of these chartlets appears as Figure 3. No. 9 of the series, the Canadian West Coast has been used (Fig. 1 & 2) to plot tsunami travel times for coastal waters, relative to forecast wave arrivals at Tofino and Langara.

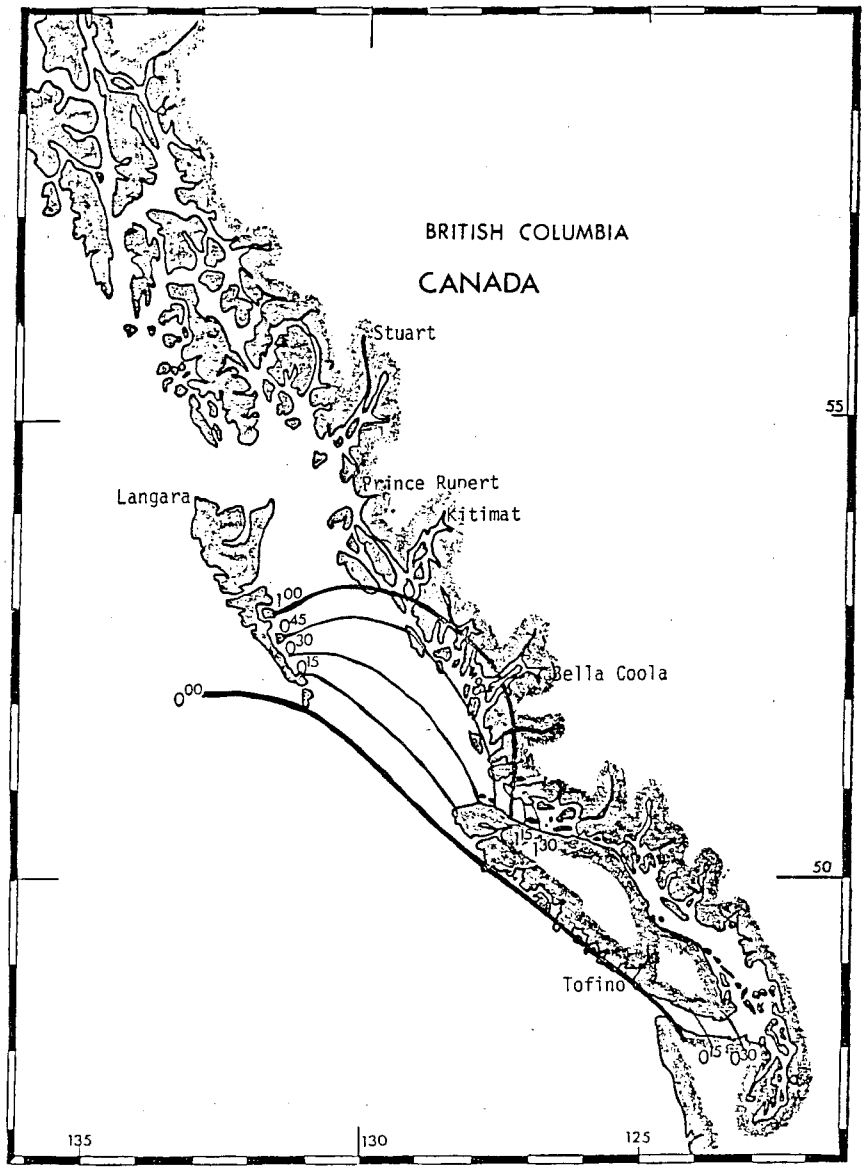


Figure 1.
Tsunami Travel Time after Reaching Tofino

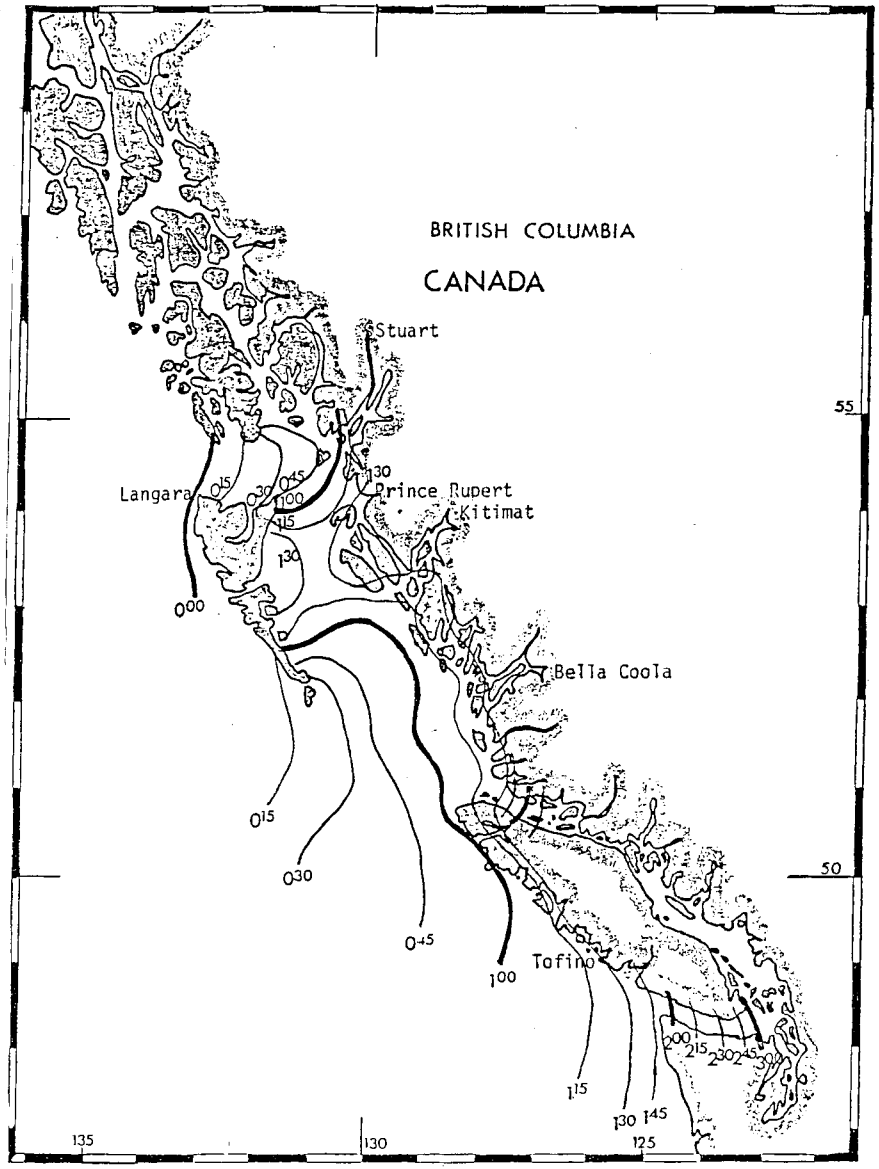


Figure 2.
Tsunami Travel Time after Reaching Langara

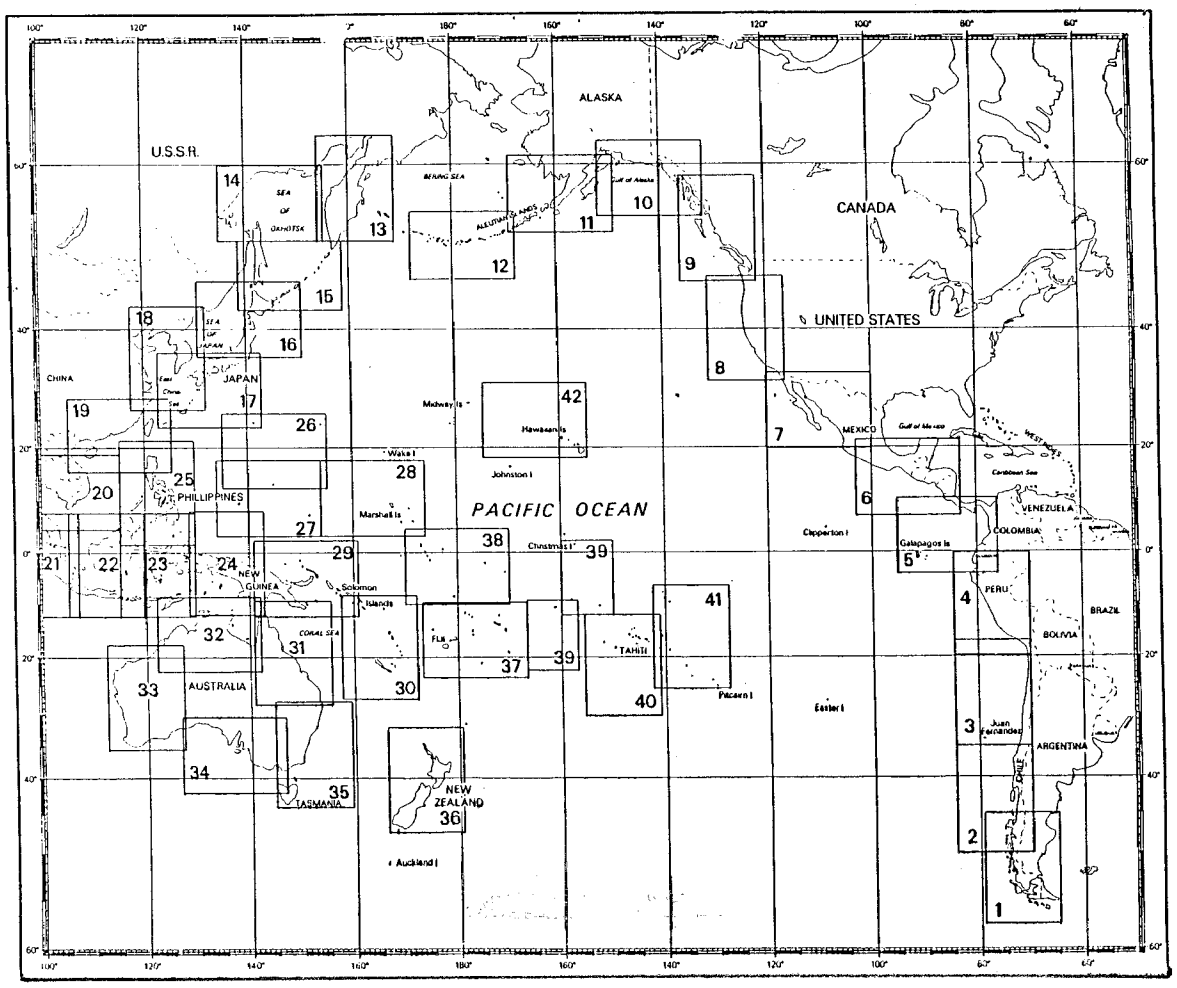


Figure 3.

Index of Charts to Identify
Tsunami Risk Zones in the Pacific

Tsunami Defense Exercises

Two tsunami defense exercises were held in 1983 on the Canadian west coast. These were organized by the Provincial Emergency Program, and co-ordinated by the British Columbia Earthquake and Tsunami Working Group. Their aims were to test:

a) the Provincial Tsunami Warning Plan for British Columbia;

b) tsunami warning arrangements within communities which are liable to experience a tsunami;

c) tsunami warning arrangements of other government departments and agencies.

The first test, entitled GOLDFISH I was held at a preset time, with participants in all offices and communities advised beforehand.

The second, GOLDFISH II was initiated about 6 weeks later at a random time, via a message from the regional office of the Federal Emergency Management Agency in Washington State. This second test gave a better evaluation of how the warning dissemination will function in a real event; showed how local authorities would assume responsibility as necessary; and exposed shortcomings that are now being remedied. We recognize the value of this testing, and GOLDFISH III is being planned for this year.

Tsunami Research in Canada

Dr. A Zielinski of Memorial University, Newfoundland, spent his sabbatical leave at the Centre for Engineering Research of the University of Hawaii (Sept. 1, 1982 - July 1, 1983) and at the Tokyo Institute of Technology (July 1, 1983 - Sept. 4, 1983) pursuing research on coastal effects and tsunami directionality. The study showed that the sparsity of tidal monitoring stations in open areas of the Pacific, north of the Hawaiian Islands for example, creates a considerable amount of uncertainty in predictions of tsunami magnitude and the degree of inundation at any specific location. A highly directional tsunami might be overestimated (a false alarm) or underestimated (a miss). In conjunction with Dr. N. Saxena of the University of Hawaii Dr. Zielinski has developed concepts and proposals for deep ocean monitoring that may help to resolve this problem.

Dr. T. S. Murty continues to serve as editor of Natural Sciences of Hazards, the International Journal of the Tsunami Society. He has also been elected chairman of the IUGG Tsunami Commission.

In his research, Dr. Murty is invoking the concept of diffusive kinematic waves to account for the very slow travel of the 1960 Chilean earthquake tsunami on the west coast of Canada. The traditional Lagrange formula for the velocity of long gravity waves such as tsunamis he finds is not applicable in frictionally dominated coastal inlets and river systems. Tsunami forerunners have been qualitatively explained as lateral waves which are diffracted long waves at continental shelf edges.

Mr. S. O. Wigen continued to coordinate internationally the Historical Study of Tsunamis. The first papers of this study have been published in Tsunamis: Their Science and Engineering, from the 1981 International Symposium in Japan. A copy of Historical Study of Tsunamis at Tofino, Canada is being distributed in conjunction with this report. Representatives of all Member States are encouraged to support parallel studies using data from their own tide gauge stations and supplementary sources. The compilation of these data are endorsed in the draft Master Plan for the Tsunami Warning System. The opportunity will be available at ITS'85 to present papers on new historical studies.

Visiting Expert Program

The Institute of Ocean Sciences at Sidney, B.C. and the associated Pacific Geoscience Centre encompass virtually all disciplilnes related to tsunami research. A specialized tsunami library of 1500 publications augments the Institute library, and computer program and facilities are on hand for the digitization and spectral analysis of tsunamigrams. The Institute is prepared to consider applications for visiting experts to use its facilities. Such visitors would appear to fall within the terms of reference of the Visiting Expert Program, as approved at the ITSU-VIII meeting.

International Meeting

Canada expects to host consecutive meetings fo ICG/ITSU and the Tsunami Commission's International Tsunami Symposium from July 29 to August 9, 1985. Both meetings will be located at Victoria and Sidney, British Columbia. It has been the expressed desire of ITSU to hold these meetings together in order to provide a much needed oppportunity for the research community to interact with those concerned with tsunami warning and community protection. This objective can only be achieved if ITSU representatives of Member States participate in the subsequent symposium. Several sessions of the symposium will address the sociological and historical aspects of tsunamis, and these will give an opportunity for you or your alternate representatives to offer papers that will focus on the problems, needs, and solutions of your specific region. We will welcome your contributions, and your participation.

CHILE

This report summarizes the activities carried out by Chile for the operation and maintenance of the Pacific Tsunami Warning System.

Intersessional activities

I. Exercises

For purpose of maintaining efficient communications in the various stations, tsunami exercises were carried out regularly in association with the Hydrographic Institute of the Chilean Navy (IHA) and the tide stations participating in the National Tsunami Warning System (Sistema Nacional de Alarma de Maremotos (SNAM)). Each exercise is evaluated and each participating station informed of any observations or faults in its execution.

Contacts maintained with the Naval Telecommunications authorities helped reduce transmission time to a minimum during the exercises. The same type of exercise is carried out at monthly intervals between the Pacific Tsunami Warning Center (PTWC) and IHA (Valparaiso Tide Observer), and through the latter, with the network of tide stations.

II. Training Course on Tsunamis

Further to recommendations by previous meetings of ICG/ITSU, IHA has developed training activities in the theory and practical use of the National Tsunami Warning System, designed for the officials and professional staff who will be participating in its operation.

Accordingly, on 3 May 1983, a two-month course was held at IHA. It included visits to the Department of Geophysics of the University of Chile (Santiago Observatory) and to the Instituto Nacional de Hidraulica (National Institute of Hydraulics), in order to demonstrate how epicentres and seismic magnitudes are determined in practice, and also to observe the effects of a tsunami in the hydraulic model of the port of Valparaiso.

The topics covered by the course are listed below:

1. Wave theory (two sessions)

1.1 Simple, harmonious movement

1.2 One-dimensional waves, basic concepts

1.3 Two-dimensional waves

1.4 Waves in general

1.5 Wave energy

1.6 Snell's law

1.7 Phase velocity and group velocity

1.8 Restitutive forces in wave motion

2. Mathematical description of tsunamis in the open sea

2.1 General hydrodynamic wave equation

2.2 Characteristics of tsunamis

2.3 Energy transport

2.4 Refraction in the open sea: application of Snell's law

2.5 Forms of generation

3. Refraction in bays (two sessions)

3.1 Application of Snell's law in shallow water

3.2 Effects on the shore

3.3 Practical aspects

4. Resonance (two sessions)

4.1 Theory of resonance

4.2 Resonance in bays

4.3 Talcahuano Bay: a special case

4.4 Gauging of resonance

5. Diffraction (one session)

5.1 Diffraction theory

5.2 Diffraction in peninsulas

5.3 Gauging of diffraction

6. Run-up (two sessions)

6.1 The theory of breakers

6.2 Gradual steepening and flooding

6.3 Variations due to topography

6.4 Effect of gradient

6.5 Effect of canalization

6.6 Gauging of run-up

7. Pacific Tsunami Warning System (one session)

7.1 General sturcture of the system

7.2 Seismic and tidal gauge stations

7.3 Warning messages

7.4 Responsibility of IHA

7.5 Co-ordination of tide stations

7.6 Responsibilitiy towards the International Tsunammi Warning System

7.7 Opitmal use of the system

8. Tide Stations (one session)

8.1 Introduction to tides

8.2 Characteristics of a station

8.3 Signs of a tsunami in tidal readings

8.4 General

9. Risk analysis in various coastal cities (four sessions)

9.1 Arica

9.2 Iquique

9.3 Mejillones

9.4 Antofagasta

9.5 Caldera

9.6 Coquimbo

9.7 Quintero

9.8 Valparaiso

9.9 Talcahuano

9.10 Corral

9.11 Puerto Montt

9.12 Punta Arenas

9.13 Puerto Williams

10. Practical recommendations (two sessions)

10.1 Review of practical applications

11. Simulations (five sessions)

Evaluation of staff reaction to tsunami dummy tests

III. Publications on tsunamis

A book on tsunamis on the coast of Chile (Maremotos en la costa de Chile) was published by IHA in 1982 (publication No. 3016), describing the generation, propagation and effects of major tsunamis that have caused damage in Chile in the past. In addition, the workings of the Tsunami Warning System are explained at both national and international levels.

A revised edition of IHA publication No. 3014 Procedimientos generales del sistema nacional de alarma de maremotos ('General Procedure for the National Tsunami Warning System') is currently in preparation.

IV. Project to set up an seismological network for tsunami warning

In order to establish an efficient warning system for tsunamis generated off the coast of Chile, IHA, as the liaison body of the Pacific Tsunami Warning Center (PTWC), and in association with the Department of Geology and Geophysics of the University of Chile, has conducted a study (now at the funding stage) on a seismologic network designed to locate quakes which are likely to generate tsunamis, usisng reliable equipment to determine epicentres.

The equipment for detection of the arrival of the initial waves, to be used on the coast, will consist of the following:

(a) a vertical, short-period seismometer (1 Hz);

(b) a detection system based on a microprocessor with filters for the warning signal, memory banks to store up to five events, and a built-in clock. In the event of a quake, a warning is immediately given, and the operator records the day and time of the first wave; these data are then sent for procesisng;

(c) 12-volt batteries for the system; these must be periodically recharged, either by electricity or by solar energy cells.

The project would involve installing initial wave detection equipment on IHA premises in the following localities: Arica, Antofagasta, Caldera, Robinson Crusoe Island, Valparaiso, Talcahuano, Corral and Puerto Montt.

The project is now being funded, and will, we trust, soon be implemented.

CHINA

Earthquake Tsunami causes less severe disasters than storm surge does in terms of frequency, intensity and destruction to the vast coastal areas of China. The Tsunami research in China, however, is never short of interest.

Research on Tsunami

Since 1967, the study group of seismology and sea level in the Marine Science and Technology Information Center, the National Bureau of Oceanography, has undertaken the study of Tsunami history in

China. The group published its report 1978, presenting rich historical information on Tsunami. In more than 2000 years from 47 BC to 1977, about 10 events of earthquake Tsunami took place in our country.

In September 49 BC, the rising water from Bohai Sea surged over the land due to earthquake with its epicentre in Laizhou Bay within Bohai Sea area. In 173 AD, Huangxian County in Shangdong Province was flooded due to earthquake in Bohai Sea. In September 1640, several counties in Guangdong Province were flooded due to frequent earthquakes. On 19 August 1670, an earthquake caused floods, drowning numerous people ashore. On 18 December 1876, a strong earthquake occurred north of Jilong in Taiwan ($25^{o}5'$N, $121^{o}7'$E) destroyed the whole city of Jilong, taking toll of hundreds of people by sea waves. On the other hand, according to incomplete statistics, in more than 2700 years from 780 BC to 1976, the coastal areas of China were visited by a total of 223 strong earthquake events exceeding 6 on Richter scale, among which 194 events occurred in Taiwan and its adjacent sea, including 90 undersea events mostly centering around the sea area east of Taiwan. It has also been noted that inshore and offshore areas of our country have witnessed in recent years a number of strong earthquakes in succession, for example, the event of 7.4 on Richter scale in mid-Bohai Sea on 18 July 1969, 6.4 scale off Yangjiang in Guangdong Province on 26 July 1969, 7.3 scale off Liaoning Province, 7.8 scale in Tangshan and 6.9 scale in Ninhe etc., causing no Tsunami with them all.

The research indicates that a few events of seismic Tsunami in the Pacific may visit our coastal areas only with their detected Tsunami waves of 15-20 cm in height and 45 or 60 minutes in period, for instance, that from Tsunami off Chile in 1960, because the impact of Tsunami is dampened upon islands and the shallow broad continental shelves off Chinese coast.

Recently, the Institute of Oceanology of Chinese Academy of Sciences, Shangdong College of Oceanology, and some other institutions have studied shelf wave theory, which is probably beneficial to the study of propagation characteristics of Tsunami waves over the shallow continental shelves.

Tsunami Monitoring and Data Analysis During 26 May 1983 Tsunami North of Sea of Japan

The National Marine Environment Forecasting Center (NMEFC) collected tidal observation data of four stations on north and east coast of China recorded from May 26 00 hours to 27 12 hours after the Tsunami event took place. The analysis of the data shows that except Tangu Station on north coast where water level anomaly of 50-60 cm was observed due to meteorological factors, the measured stations gave the anomaly of ca. 10-20 cm which is within the probable error of tidal forecasting.

Programme Development in Tsunami Warning and Research

The National Bureau of Oceanography in China has instructed its NMEFC to develop a programme on Tsunami monitoring and warning. It is initially planned to put into operation two tidal stations of Kanmen in Zhejiang Province and of Xiamen in Fujian Province for PTWS. The programme will be carried out in collaboration with the Central Anti-Floods Headquarters, the State Bureau of Seismology, the State Meteorological Administration and the Ministry of Post and Communication. The proposed Tsunami Warning System in China is also responsible for storm surge monitoring and warning throughout China. The full operation of the system will commence in 1985. It is also planned to unfold Tsunami research in NMEFC and some other institutions of oceanography.

We hope to cooperate with ICG/ITSU, IOC and other countries in the field of Tsunami monitoring, warning and research and related aspects, with a view to doing a better job in this field for the benefit of people in China and throughout the Pacific region.

COLOMBIA

The Secretary-General of the Colombian Oceanographic Commission, the Colombian contact for ICG/ITSU, extends his greetings to Dr. Mario Ruivo, Secretary of IOC, and reports below on Colombia's activities and proposals concerning the Tsunami Warning System in the Pacific, in reply to his circular letter No. 925 of 5 September 1983.

1. Background

(a) Colombia joined ICG/ITSU at the beginning of 1981, the Colombian Oceanographic Commission being designated to liaise with IOC, ITSU and ITIC for the development of the Colombian Tsunami Warning Centre and incorporation into the international system in the Pacific.

(b) In February 1983, by order of the President of the Republic and after several months' review of the Colombian situation in regard to the marine sciences, the Colombian Oceanographic Commission was restructured, with the establishment of a National Council as the supreme authority in conformity with major national directives concerning marine science and technology, a General Secretariat with its own scientific and administrative infrastructure and independent headquarters and several technical committees comprising representatives of all members of the Colombian Oceanographic Commission and permanent advisers to the

General Secretariat in the various branches of the marine sciences (biology, geology, pollution, human resources and supprot services). The process of restructuring and organizing the Colombian Oceanographic Commission took six months to complete, and I can inform the Secretary that Colombia now has a national body co-ordinating all aspects of marine science and technology, with an independent administrative structure and adequate financial resources to suppport the programmes envisaged in the National Plan for the Development of Marine Sciences and Technologies.

(c) The National Oceanographic Council is currently examining the report of the Secretary-General on the work of the Technical Committees, which met in November 1983 to consider fifty-three draft research projects calling for an investment of approximately US $16.1 million, the highest co-ordinated scientific input in Colombia in the field of marine science.

(d) This remarkable progress can be seen as the result of the interest shown by the Colombian Government and the Colombian Oceanographic Commission in developing marine studies in a consistent, vigorous and lasting manner, and the National Oceanographic Council's present feeling and wish to reflected in genuine optimism about the future, as regards both national projects currently being planned and the attention that will be given to international commitments including IGOSS, ITSU, IODE, IOCARIBE and TEMA.

(e) The Secretary will be aware that a complete overhaul of the administration of marine science and technology cannot be done in a matter of days, which is why I beg him to make allowances for the situation of the past two years. I do, however, have faith and confidence in the new infrastructure and, am sure that, with the support of my government, Colombia will now be in a better position to meet its international commitments.

2. Present Situation

The Secretary-General has instructed the Programme Co-ordination Office and the International Affairs Liaison Office of the Secretariat to provide updated information about the country's infrastructure as regards the ITSU system.

The National Committee for the study of tsunamis was consequently set up; it held its first meeting to evaluate the system on 12 January last.

The organization of the National Committee is as follows:-

- CCO Secretary-General--Co-ordinator--National Contact

- Under-Secretary for International Organizations and Conferences Ministry of External Relations

- General Maritime and Port Directorate--National Maritime Authority

- Geophysical Institute of the Andes--Javeriana University

- National Institute for Geological Mining Research--INGEOMINAS

- Agustin Codazzi Geographical Institute

- Institute for Meteorology, Hydrology and Land Development--HIMAT

- Colombian Civil Defence

- Two advisers to the General Secretariat for the co-ordination of international programmes and affairs.

At its first meeting the National Committee dealt with the following topics:

- Review of the present situation

- Proposal of the National Committee to implement the National Tsunami Warning Plan

- Recommendations to IOC, ICG/ITSU and ITIC

3. Summary of the Present Situation

The following conclusions can be drawn from the analysis of the country's situation in regard to the Tsunami Warning System:

(a) Colombia has two standard tide-recording gauges in the Pacific, one of these is at Buenaventura and the other at Tumaco. Tidal information is collected and stored at the Agustin Codazzi Geographical Institute. The Colombian Institute for Hydrology, Meteorology and Land Development (HIMAT) is interested in taking responsibility for the national tide-recording network and would be in charge of the tide-recording network and its communications network in the future, incorporating it into the world telecommunications system through the HIMAT exchange in Bogota, which is already in operation, as an alternative to the GOES satellite or the NASA satellite offered to the CERESIS group.

(b) Colombia has a well-integrated seismological network equipped with the only SRO system in South America. Now it is preparing a project through the Geological Mining Institute (INGEOMINAS) to establish in the Pacific in areas of high seismic activity modern stations to be incorporated

into the national network.

(c) The Secretary-General of the Colombian Oceanographic Commission has applied to the National Oceanographic Council for an allocation of US $20,000 for 1984 to cover work related to ITSU.

(d) There is practically no provision for raising awareness and educating the general public on the Pacific seaboard of Colombia, and a comprehensive national programme is needed.

(e) The Colombia Civil Defence has organized five Civil Defence Groups on the Pacific coast, comprising of 160 voluntary workers who require training and instruction so as to conduct educational campaigns among local communities. It also has three local branches and a regional centre responsible for the Pacific coast, with 4,988 voluntary workers.

(f) There is no Colombian personnel specially trained to install, operate and maintain a modern seismological and tidal station like those in other countries of the ITSU system.

(g) No scientific studies have been carried out in Colombia on the composition and integration of a tide-recording and seismological network for the Pacific.

(h) There is a shortage of information which must be made good, particularly in regards to technical documentation and documentation on the Tsunami system.

(i) As part of the activities of the marine meteorology service and in co-ordination with the Navy and other government bodies, HIMAT has made provision for the current year for the detachment of agents to the main seaports of the country, who will carry out initial liaison work for the transmission and reception of meteorological and oceanographical data.

4. Proposal by the National Tsunami Warning Committee

It is proposed to undertake technical and scientific studies to establish the National Tsunami Warning Service in Colombia, action being planned in the following areas:

(a) A study with a view to establishing a seismographical network of the Pacific coast of Colombia (computerized) and incorporating it into the ITSU system, with foreign technical advice.

(b) A study with a view to establishing a computerized tide-recording network on the Pacific coast of Colombia.

(c) A training and familiarization plan for technical personnel responsible for the installation, operation and maintenance of tidal and seismological stations.

(d) A study of the most appropriate communications network to link the stations with each other and with the world telecommunications system, the GOES system, or the NASA satellite offered to CERESIS.

(e) Development of a plan to educate the general public on the Pacific coast in dealing with a possible Tsunami emergency.

(f) A final consolidated project for the Colombian Tsunami Warning System to be presented to IOC, ITSU, the special inspection group of UNDP and other agencies for the purpose of seeking funds to finance the project.

5. Requests and Recommendations to IOC, ITIC and ICG/ITSU

It emerges clearly from the foregoing that Colombia is in need of the basic technical infrastructure both to train personnel and to launch the National Tsunami Warning Plan. The Secretary-General of the Colombian Oceanographic Commission, with the approval of the National Committee, consequently submits the following formal requests and recommendations to the Secretary of IOC and, through him, to the Director of ITIC and the Chairman of ICG/ITSU:

(a) It is requested that a group of ITIC experts (technical) be set up and sent to Colombia to advise the Colombian authorities on the preparation of the National Tsunami Warning Plan and make recommendations on the selection of stations, equipment and communication systems to link up the system.

(b) It is requested that a mission of civil defence experts be dispatched during the first week of April 1984 to conduct a workshop seminar on aspects of tsunami warning, preparing the public for emergency and evacuation procedures, and also that, taking advantage of this opportunity, the experts be asked to monitor the mock warning exercise to be carried in Tumaco during that week.

(c) Once the National Tsunami Warning Plan has been drawn up, it is requested that a visit be made to Colombia by the UNDP Special Committee so that the plan can be submitted and ways sought of financing the plan with international assistance.

(d) In reply to the circular letter of 5 September 1983, IOC is requested to set aside two places for trainees who will ultimately be in charge of the system's implementation. These are requested for the second half of 1984 to 1985. The candidates are currently being selected.

6. Final Conclusion

The Colombian Committee of the Tsunami Warning System is aware of the tasks that lie ahead and hopes to do everything in its power to incorporate the country into ITSU within the shortest possible time.

It is also aware that there is a latent tsunami threat and that at any time the tragedy which struck the Pacific coast of Colombia in December 1979 could occur again, as could other types of emergency affecting the Pacific community.

It therefore accords the highest priority to its incorporation into the International Tsunami Warning System in order to work together with its Pacific neighbours in preventing tsunami disasters.

It recognizes the extraordinary efforts deployed by IOC, ITIC and ICG/ITSU in developing the system and is grateful for these bodies' interest and co-operation in enabling Colombia to prove itself equal to other Pacific countries in monitoring and preventing tsunamis.

ECUADOR

Capt. Raul Toledo Echeverria, Director of the Oceanographic Institute of Ecuador, submitted a copy of the Ecuadorian Report in July 1984. The report was prepared by Engineer Jose Chang. It emphasizes in particular the important role that the GOES satellite tide platform at Baltra Island has played in the past for the Tsunami Warning System and of the need to maintain such a tsunami station at Galapagos Islands. Also, the report informs of the different additional activities for education and tsunami preparedness in Ecuador. A copy of the report in Spanish can be made available by writing to ITIC.

FIJI

Introduction

The present report summarizes the actions taken by the Mineral Resources Department of Fiji since the Eighth Session of ITSU in Fiji (April 1982).

Fiji became a full member of ITSU in March 1978 and has consequently responded to the best of its ability to the objectives approved in the resolutions and recommendations of ITSU. Fiji's initial project was to form a Tsunami Working Group comprised of personnel from the Military Forces, news media, Emergency Services

Committee (EMSEC), Marine Department, Communications and Mineral Resources Department. The Group is Responsible under EMSEC for the public preparedness for tsunamis, their rehabilitation after a significant tsunami event and for the development and implementation of a Tsunami Warning System.

General Activities, 1982-83

Earthquake activity is monitored by a network of 13 stations telemetered into the central observatory in Suva. A seismograph station also operated at the Weather Office, Nandi, and is useful for providing P-arrivals to the PTWC, Hawaii, via the Nandi Communications Centre.

The Communications Centre at Nandi also relays seismic information and alerts from PTWC to other S. W. Pacific countries.

The only tsunami warning tide gauge operating in Fiji is situated in the Suva Harbour wharf and records at the Police Information Centre and at the Marine Department.

No tsunami was recorded on the gauge from April 1982 - April 1983. However on the only occasion when a very small tsunami may have been recorded (19 Dec 1982, earthquake MS 7.7, south of Tonga Is) the gauge was inoperative.

The largest 1982 earthquake in the Fiji Islands region with MS 6.3 on 29 March did not cause a significant tsunami.

Regional Communications

Tsunami Working Group

Tsunami Working Group members attended a meeting called by the Emergency Services Committee to discuss improvements to the regional communications during and after natural disasters.

Warnings will be broadcast by several regional broadcast stations with back up radio communications to the central Fiji Broadcasting Commission's station at Suva. Warning will also be issued via the Police Communications Centre telex system which has the facility to simultaneously issue messages to Police Stations at main centres in the Fiji Islands.

PTWC System

The modified PTWC warning system was introduced on 1 March 1983 and a map of the regional tsunami travel times was issued to participants in the warning system.

Historical record of Fiji Islands Tsunamis

Research carried out by the Mineral Resources Department on earthquakes since 1850 revealed the following information on tsunamis and their generation.

Tsunami History

Only two noticeable tsunamis are known to have been caused by local earthquakes in the Fiji islands region. The first, in 1881, with amplitude 2 metres was caused by an earthquake in a known zone of seismicity to the north of Vanua Levu. The second known tsunami, amplitude 2 metres, resulted from an earthquake in 1953, with magnitude MS 6.75, which occured offshore from the Suva area in southeast Viti Levu.

The Suva tide gauge has recorded very small amplitude tsunamis originating outside the Fiji region (e.g. 22 June 1977 Tonga source-16 cm amplitude) but there is no record of the largest tsunamis generated in Samoa and Tonga (1917, 1919) or other active zones adjacent to Fiji having a noticeable effect in Fiji.

Of the very large tsunamis generated around the Pacific margin only one (May 1877, Chile) caused any noticeable effect namely, three 2 metre waves on at one locality the south coast of Vanua Levu.

The historical record indicates the tsunami risk results primarily from earthquakes within the Fiji region. The largest earthquake donot necessarily occur in recognizable seismic zones and can be expected anywhere in Fiji.

Tsunami generation

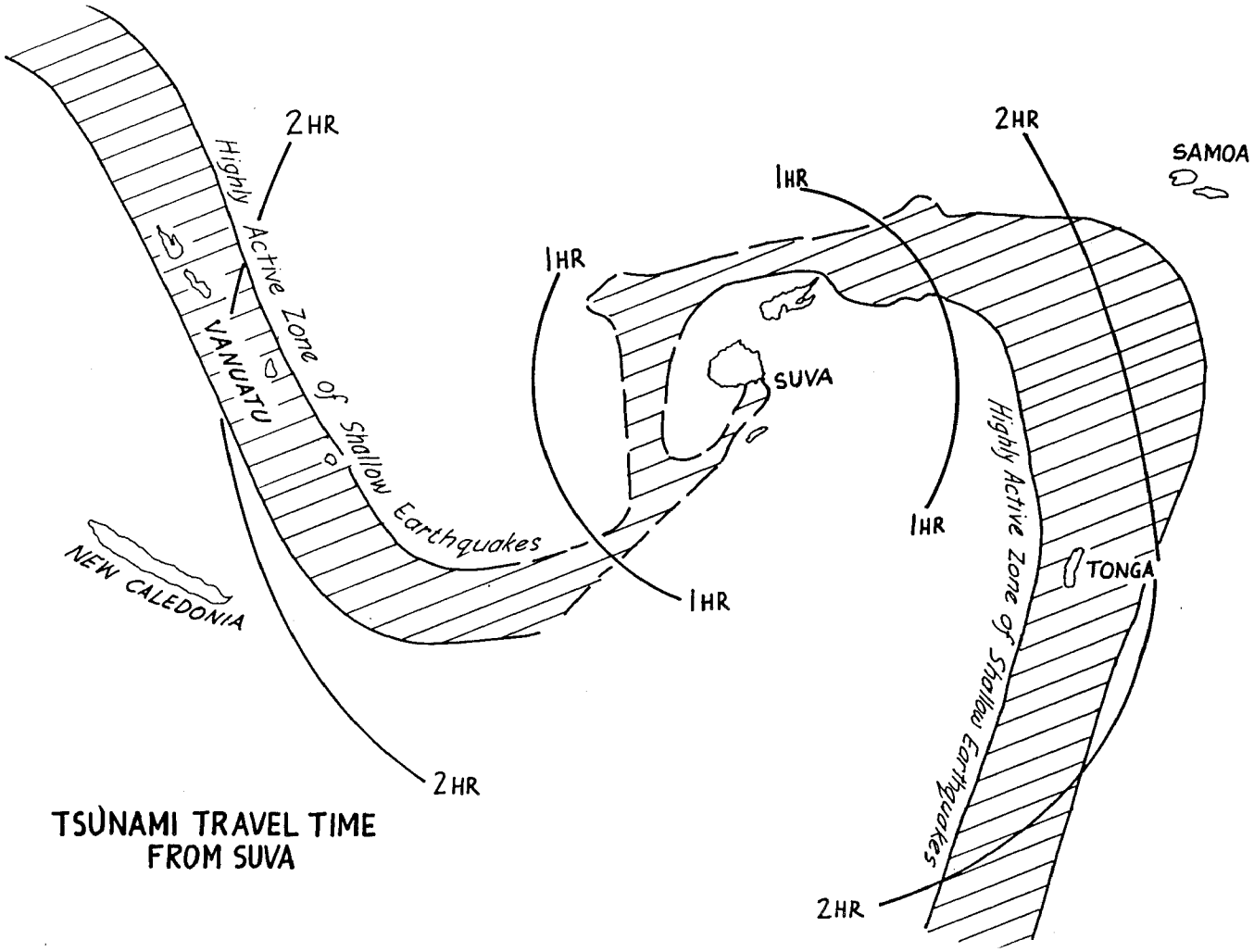
Earthquakes in the well defined offshore zones of west, north and northeast of Fiji are associated with strike-slip faulting so that the risk, of tsunamis generated by vertical displacements of the sea floor resulting from an earthquake fault is diminished.

Tsunamis are more likely to be caused by submarine slumping of unconsolidated sediments down the steep slopes of fringing or barrier reefs or submarine canyons. The 1953 Suva earthquake (with a strike slip focal mechanism) generated a tsunami in this manner.

However earthquakes with magnitudes in the range 6.5-7.0 shook Koro (1932) and the Rambi - northern Taveuni area (1919, 1932, 1979) with high intensity but tsunamis were not generated. The potential source areas for tsunamis are those where offshore sediments are being rapidly deposited and the sea floor has steep gradients. Southern Viti Levu and possibly north-eastern Vanua Levu coastal zones are potential tsunami source areas.

Most disastrous tsunamis are generated by major shallow earthquakes with magnitude 7.5 or more and, although such large earthquakes are not known to have occurred in the Fiji region, the possibility of such an earthquake must be taken into account because a tsunami would be highly likely regardless of where the earthquake was centred.

TSUNAMI TRAVEL TIME FROM SUVA



TSUNAMI TRAVEL TIME FROM SUVA

FRANCE

France maintains two seismic networks and a set of tide station in Pacific, in Polynesia and in the New Caledonia - Vanuatu area. Part of the records are routinely communicated to the Tsunami Center in Hawaii. As Polynesia is more subject to Pacific wide tsunamis than New Caledonia a local warning procedure exists in Polynesia based on amplitudes of body and surface waves and on the magnitude of T phases generated by the major earthquakes.

Tsunamis Research in New Caledonia and Polynesia

In cooperation with the P.I.D.P. program of the East West Center (University of Hawaii), J.F. Dupon. ORSTOM NOUMEA, New Caledonia is working on natural hazard mainly in the topic of damages from hurricanes. Looking historical data, J.F. Dupon is taking from the available documentation all informations about tsunamis and earthquakes in the New Caledonia area. Historical data provides evidences of tsunami occurences on the East shore of Lifou (Loyalty Islands) in 1793, 1875. After March 1875 earthquakes 25 peoples died in Lifou due to the generated tsunamis. Height of the waves is estimated around five meters. It was known, this swarm of earthquakes has generated important waves in southern Vanuatu but no data was published for damage in the Loyalty Islands group. Existence of a marked wedge in the bottom of the trench in front of Lifou explains the origin of this consequent local tsunami.

Informations about tsunamis were collected too in Wallis and Futuna Islands. There are no report about Pacific wide tsunamis but at Futuna some local tsunamis follows earthquake from the transform fault linking Fiji to the Samoa. This fault is 40 km in the South of Futuna. In Polynesia, historical researches on tsunamis are performed using available documents and archeological data.

HONG KONG

Introduction

Activities of the Royal Observatory from 1981 to 1983 and future plans related to the Tsunami Warning System in the Pacific since the 8th Session of ITSU are described in this report.

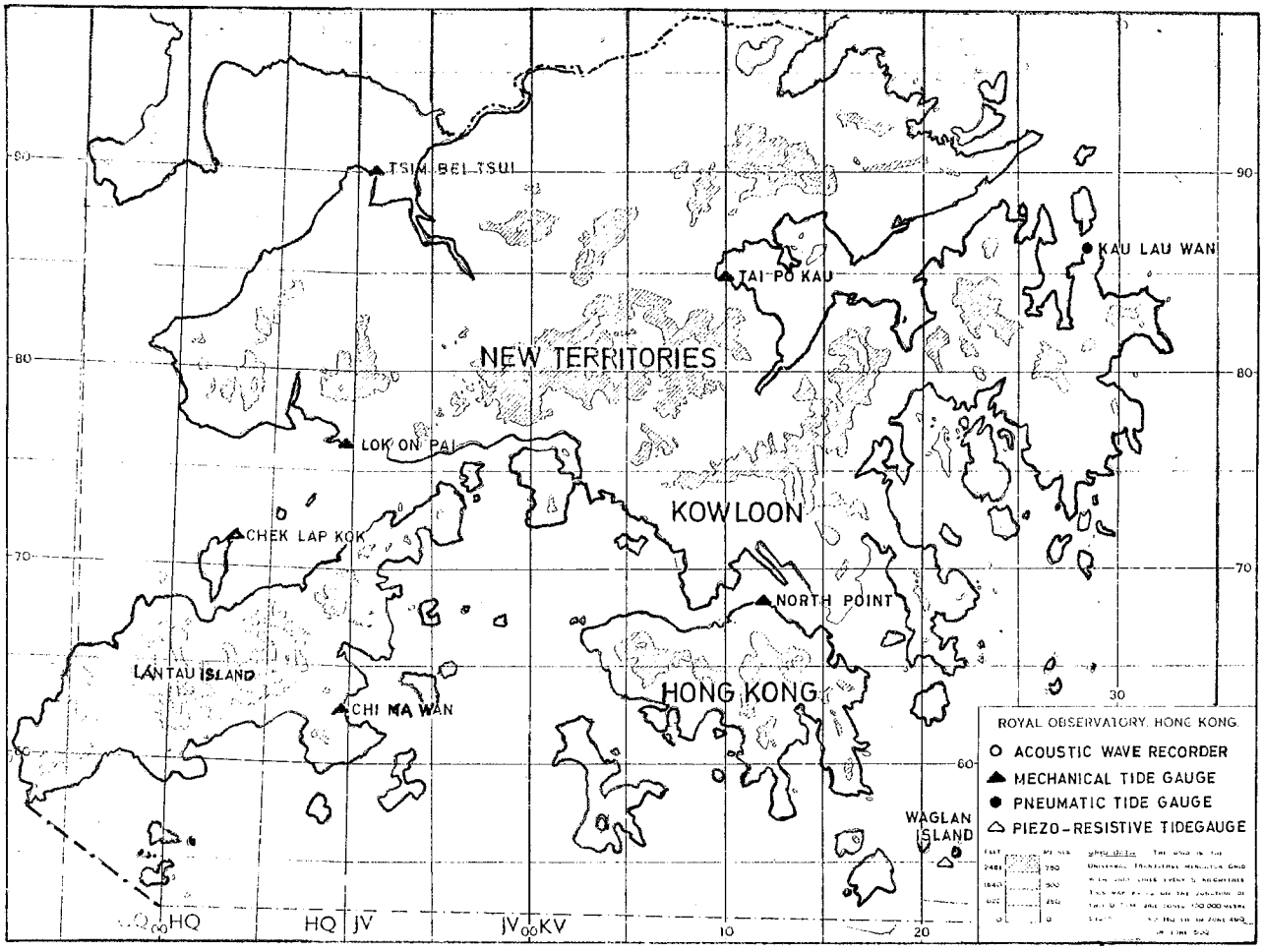
Intersessional Activities

As already been reported, Hong Kong joined the International Co-ordination Group for the ICG/ITSU as a member in 1978 and established in 1979 a local tri-station short-period seismograph network which monitors earthquakes in the South China Sea and South China and forms part of the Seismological Network in Southeast Asia.

There are eight tide gauges in operation in Hong Kong. They are located at Waglan, Kau Lau Wan, Chi Ma Wan, Tsim Bei Tsui, Chek Lap Kok, Lok On Pai, North Point and Tai Po Kau (see map below). Real time data from the last four sites are telemetered back to the Royal Observatory by telephone lines. A wave recorder installed at Waglan is in operation since November 1981.

Future Plans

There are plans to increase the density of tide gauge network and telemeter real time data back to the Royal Observatory. It is likely that in the near future, the North Point gauge would be resited to Quarry Bay in Victoria Harbour and the worn-out gauges at Waglan and Kau Lau Wan would be replaced. There are also plans to add one more station to the short-period seismograph network and to develop real time seismic data processing to increase the accuracy and reduce the time for the determination of parameters for earthquakes occurring in and near Hong Kong.



Locations of Tide Gauge and Wave Recorder in Hong Kong

JAPAN

Introduction

The most important event in Japan related with ITSU since the Eighth Session held in Fiji, is the tsunami caused by the Japan Sea Earthquake on 26 May 1983.

In this report, after a brief description of the watch system of earthquakes and tsunamis of the Japan Meteorological Agency (JMA), an outline of the tsunami caused by the earthquake is described in some detail. Measures taken by JMA and other organizations, to mitigate dsiasters caused by tsunamis are also explained.

Tsunami Warning Services in JMA

As already reported in the National Reports presented to the past ITSU meetings, since 1952 JMA is responsible for issuing tsunami forecasts and warnings after the occurrence of an earthquake in a sea area.

For the tsunamis caused by an earthquake in a near submarine area, a nearby local center is responsible for issuance of warnings. The headquarters of JMA backs up the local center. There are six local centers. They are in Sapporo, Sendai, Tokyo, Osaka, Fukuoka and Naha. These centers are in District Meteorological Observatories (DMO) under JMA except for Tokyo DMO for which JMA headquarters performs the work. Twenty minutes after the occurence of an earthquake is the time limit for tsunami warning issuance of a local center.

JMA has improved its data dissemination and editing system called ADESS (Automated Data Editing and Switching System). Along with the commissioning of L-ADESSes (local ADESSes), the ADESS at JMA headquarters in Tokyo was upgraded in 1981 and designated as C-ADESS (Central ADESS). Each of local centers except Naha has an L-ADESS. The new system reduced considerably the time for urgent determination of parameters of earthquakes occurring in and near Japan. Furthermore, tsunami warnings are automatically transmitted from the local center to relevant organizations. This remarkably shortened the time for tsunami warning procedure.

Permanent Ocean Bottom Seismograph (OBS) Observation System off the southern coast of the Tokai District, central Japan, which was reported in the National Report of the previous ITSU meetings, has been operating very satisfactorily. Tsunami meter using a quartz pressure gauge attached to the terminal apparatus is found to be a very efficient instrument. To enhance its monitoring capability for seismic activities and related phenomena in the southern Kanto area including Tokyo. JMA is going to set up another OBS system of the same type off the south-eastern coast of the Boso peninsula by 1986.

Tsunamis Caused by the Japan Sea Earthquake, 1983

On 26 May 1983, a large earthquake occurred off Akita and Aomori Prefectures in northern Japan. Focal parameters of the earthquake are as follows:

Origin time	$11^h59^m57.5^s$	26 May 1983
Epicenter	$139^o04.6'E$	$40^o21.4'N$
Focal depth	14 km	
Magnitude	7.7	

Sendai District Meteorological Observatory issued a tsunami warning of the highest degree "Great Tsunami" at 1214, for the areas on the Japan Sea coast in northern Honshu, the main island of Japan. Sapporo DMO issued warning "Tsunami" at 1214 for Hokkaido coast on the Japan Sea. JMA in Tokyo issued warning "Tsunami" at 1213 for the coast of central Honshu on the Japan Sea, and the other centers issued tsunami advisories.

The warnings and advisories were transmitted through telephone networks of Nippon Telegraph and Telephone Public Corporation, Police forces, and prefectural offices to municipal authorities of the areas on the Japan Sea. The Japan Broadcasting Corporation (NHK) nationally broadcast the warnings at 1219.

However, the first tsunami waves reached the coast of Aomori and Akita prefectures at 1207 and 1208. One hundred persons were killed by the tsunami in Akita, Aomori and Hokkaido prefectures. (Another four persons were directly killed by the earthquake.) Tsunamis attacked repeatedly the areas along the Japan Sea and began to weaken gradually late at night. The Tsunami Forecasting Center (JMA center and DMO centers) terminated the warnings and advisories during 2058 to 2330.

Tide gauge records of about 70 stations all over the Japanese islands have been gathered. Tsunamis are identified on tide gauge traces of 63 stations. Arrival times of the first waves, the maximum heights and other elements have been closely analyzed. It is found that tsunamis were recorded not only on the Japan Sea coast but also on the Okhotsk Sea and Pacific coasts.

The first waves of tsunami reached Fukaura, Aomori Prefecture, at 1207; Oga, Akita Prefecture, at 1208; Ryotsu in Sado Island, at 1248; Saigo in Oki Island, at 1333; and Izuhara in Tsushima Island, at 1524. The first waves of tsunami began as a rise at most of the tide gauage stations but began as a fall at eight gauge stations near to the east of the tsunami source area. This suggests that subsidence of sea bottom took place in the eastern half of the source area.

Periods of recorded tsunami waves are five to fifteen minutes at many tide gauge stations, but it was observed by many eyewitnesses and recorded by video cameras that the tsunmai grew to steep wave crests and breaking waves of very short periods. Tsunami waves continued to

the following day at most stations, and were recognized at a few stations even two days after the earthquake. The long duration of the tsunami could be considered to be due to the multiple reflection by the coasts of the Japan Sea.

The maximum heights of recorded tsunami is 194 centimeters at the Noshiro Port station (the tide gauge went out of scale upon arrival of the second wave). The second highest is 127 centimeters at Ryotsu Station and the third is 124 centimeters at Iwanai Station.

The tsunami source area estimated from the reversal transmission chart is about 150 km long in the north-south direction and about 90 km wide in the east-west direction. By comparison between the estimated tsunami source area and the aftershock area which corresponds to the thrust fault area of the earthquake, it is found that the tsunami source area is wider than the thrust fault area in the east-west direction and extends to the east. This suggests that the gradual crustal movement took place co-seismically in the adjacent area to the thrust fault area.

Damage due to the earthquake is found only in Akita, Aomori and Hokkaido prefectures. On the other hand damage due to tsunamis occurred in eight prefectures: Hokkaido, Aomori, Akita, Yamagata, Niigata, Ishikawa, Kyoto and Shimane.

The fishery industries suffered from heavy damage: 255 boats sunk, 451 boats washed away and 1187 boats damaged. Many fishing implements were also washed away. Many houses were damages or inundated and crop fields were flooded.

Run-up heights of the tsunami waves were surveyed at 170 points along the Japan Sea. The run-up heights of tsunami were high in Hokkaido, Aomori and Akita Prefectures. The maximum height was 6.6 meters at Hachiryu-cho in Akita Prefectures. However, higher run-up heights than 10 meters are reported by other surveyers.

The total amount of damage came up to 150 billion yens ($800 million).

Further Efforts to Mitigate Tsunami Disasters

In order to mitigate disasters caused by tsunamis, the National Land Agency which handles and coordinates the matters related to natural disasters, convened a meeting of concerned government organizations such as JMA, National Police Agency, Maritime Safety Agency and Fire Defence Agency, to discuss measures for tsunami disaster, including improvement of the tsunami warning system in each organization.

JMA is now trying to shorten the time to issue the tsunami forecast after the occurrence of a large earthquake. The first step is the improvement of the software related to the tsunami forecast including the immediate determination of source parameters, such as

hypocenter and magnitude of the earthquake. The second step will be the upgrading of the hardware of the tsunami forecasting system. Final goal is the full automatic forecast after the occurrence of a large earthquake in a sea area.

JMA is also trying to improve the dissemination of tsunami warnings and advisories as well as earthquake and tsunami information by full automation ultimately.

Furthermore JMA has produced leaflet to enhance the awareness of the general public about the tsunami threat and to show how to avoid tsunami disasters, and has disseminated them through municipal authorities to the general public. The leaflet shows the following general guide which was discussed and approved by the said meeting.

1. If you feel a strong earthquake on the seashore, flee to higher ground immediately.

2. Get information from radio, T.V. and public information service, etc.

3. If you have learned of issuance of tsunami warning, leave the seashore immediately, even if you have not felt an earthquake.

4. Stop swimming or fishing if you have learned of issuance of tsunami forecast, even if it is a tsunami advisory.

5. Be on guard as long as the tsunami warning or advisory is in effect, because tsunamis generally attack seashores repeatedly.

The government organizations other than JMA also have taken necessary steps to improve systems and procedures for the mitigation of tsunami disasters.

NEW ZEALAND

Tsunami Incidence

In the period between the 8th Session of ICG/ITSU and the end of 1983, no tsunamis were recorded in New Zealand although two large submarine earthquakes occurred relatively close to the country. The first of these, on 7 July 1982, was located approximately 1,000 km south of New Zealand near Macquarie Island and had a Richter magnitude of 7.1; the second, on 19 December 1982, was located in the Kermadec Trench approximately 1,200 km north of New Zealand and had a Richter magnitude of 7.4. This latter event resulted in slight sea wave activity at Papeete, Tahiti (maximum wave height 15 cm) and Pago Pago, American Samoa (maximum wave height 9 cm).

The Kermadec Trench is formed by the subduction of the sea floor at the boundary of the Indo-Australian and Pacific lithospheric plates and, although it is the source of relatively frequent large earthquakes, there is no record of their association with major tsunamis. New Zealand is fortunate in that it has not experienced any major tsunami for at least 200 years. However, tsunamis - usually those originating near South America - have resulted in oscillations in the water levels (seiches) of harbours situated along New Zealand's east coast and consequent damage to property.

To assist local Civil Defence authorities in compiling emergency action plans, the New Zealand Oceanographic Institute, Department of Scientific and Industrial Research, has applied existing numerical models to particular coastal locations in order to determine the likely seiching and run-up effects of a tsunami. In addition, an M.Sc. thesis has been completed by Mr. De Lang, University of Waikato, which examines the tsunami risk presented by the possible explosion of White Island, an active volcano located nearshore in the Bay of Plenty, a large indentation on the east coast of North Island, New Zealand.

Tsunami Warnings

The Warning Procedures adopted by the Pacific Tsunami Warning Centre (PTWC) in response to Resolution ITSU-VIII.3 "Establishment of Warning Procedures," have proved successful and the Director and staff of PTWC are to be commended for their efforts in initiating these new procedures. It is hoped, however, that progress continues with Resolution ITSU-VIII.4 "Establishment of Tsunami Warning Systems and Improvement of Present Communications." The fact that the Assistant Director of New Zealand's Ministry of Civil Defence, Mr. John Flavell, attended the 8th Session of ICG/ITSU and made valuable personal contacts with ICG/ITSU members and the Director, PTWC, has also proved to be most beneficial in the operation of the Tsunami Warning System.

Training and Education:

Training and education programmes regarding tsunamis continue to be pursued by the Ministry of Civil Defence and a major exercise which involved the arrival of a large Tsunami following an earthquake off the west coast, South Island, New Zealand, was held during 1983. An important development has been the establishment of a national Civil Defence Training College which obviates the previous need to send students to Australia. Staff members of the New Zealand Oceanographic Institute have given lectures on tsunamis to local Civil Defence authorities and have presented exhibitions of tsunami photographs and audio/visual displays to the general public.

USA

I. Introduction

In the United States, the Tsunami Warning System (TWS) is operated by the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS). Another component of NOAA, the National Ocean Service (NOS), is primarily responsible for the maintenance of U.S. tide gauges in the TWS. Tsunami research is conducted by NOAA's Environmental Research Laboratories and by various universities under the direction of the National Science Foundation. The World Data Center-A (Tsunamis) is operated by NOAA's National Environmental Satellite, Data, and Information Service. The U.S. Geological Survey (USGS) is responsible for seismological research and assists the TWS through the provision of real time seismic data and in instrument maintenance and development.

II. General

Restructuring within the NWS Headquarters and the acceptance of a position in another government agency by the U.S. National Contact resulted in a realignment of the NWS internal management of the tsunami program. The Director of the NWS Pacific Region, Richard H. Hagemeyer has been designated as the Tsunami Program Manager with the responsibility for overall management and technical oversight of the program. Mr. Hagemeyer has also been designated as the United States National Contact to ICG/ITSU.

The United States has continued to operate two major Tsunami Warning Centers since the eighth session of the International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU) in April 1982. These Centers, the Pacific Tsunami Warning Center (PTWC) in Ewa Beach, Hawaii, and the Alaska Tsunami Warning Center (ATWC) in Palmer, Alaska, have access to large arrays of seismic and tide stations, either directly via telemetry from remote locations or indirectly via messages from local observers.

A number of significant improvements in the facilities of the Centers have been accomplished over the last two years. The physical size of the ITIC was almost doubled and it now has space to accommodate adequately a Deputy Director and at least one visiting scientist in addition to the regular staff. Additional space was constructed at PTWC and expanded and improved emergency power was installed. An expanded uninterruptable power system with supporting emergency generators and facility construction is under design for the ATWC.

The tenth edition of the Communication Plan for the Tsunami Warning System has been completed and recently issued. Responsibility for maintenance of the Communication Plan has been delegated to PTWC.

III. Center Operations

A. PACIFIC TSUNAMI WARNING CENTER (PTWC)

Operational Summary of Tsunamigenic Events

During the past two years, PTWC issued only one tsunami watch. This was in connection with the earthquake of March 18, 1983, near Rabaul, New Britain. A minor tsunami was generated in that area with 22 cm recorded at Rabaul and small waves along the southeast coast of New Ireland.

Investigations with queries to tide stations were initiated for several events, some associated with minor tsunamis. An exception was the earthquake of May 26, 1983, in the Sea of Japan. A major tsunami impacted the coasts of northern Honshu and southern Hokkaido, with waves reaching the USSR and Korea. A tsunami watch was not issued for the Pacific basin community because of the confined locations within the Sea of Japan.

Minor tsunamis were reported for the following investigations:

December 19, 1982 - Tonga-Kermadec trench; 9 cm reported at Pago Pago, American Samoa; 15 cm at Papeete, French Polynesia; 4-7 cm at Hawaii;

December 28, 1982 - South of Honshu, Japan; 22 cm reported at Hachijojima near the epicenter location;

March 12, 1983 - Indonesia; unconfirmed local tsunami on Seram;

June 21, 1983 - Sea of Japan; 40-100 cm waves reported along west coast of northern Honshu, Japan;

October 4, 1983 - Northern Chile; 150 cm fall in sea level reported at Chanaral near the epicenter; 10-20 cm reported at Valparaiso, Chile.

Seismic Data Acquisition

Over the past two years major improvements in seismic data acquisition have been implemented at the Pacific Tsunami Warning Center. By the beginning of 1983, a 2400 baud, full-duplex data circuit was installed between PTWC and the National Earthquake Information Service (NEIS) of the U.S. Geological Survey, located at Golden, Colorado. This dedicated circuit uses satellite communications between Hawaii and California, and land lines from California to Colorado. As the basic governmental agency responsible for the reporting of earthquake data, NEIS is a central collection point for recording data in real-time from a network of seismic stations extending across the mainland United States and including Alaska. Completion of the data circuit to PTWC enables the transfer of Hawaii data to NEIS and the transfer to PTWC of selected seismic stations being recorded at NEIS. At

present, seismic data from 14 stations (9 short-period and 5 long-period seismometers) are being telemetered to PTWC in real-time. These stations include Blacksburg, Virginia; French Village, Missouri; Albuquerque, New Mexico; Glamis and Jamestown, California; Golden, Colorado; Newport, Washington; and Palmer, Adak, and Shemya, Alaska. With Honolulu included, the distribution of seismic stations recorded at PTWC extends from the East Coast to Hawaii to provide azimuthal control for locating quakes in Central and South America, and from the western mainland States to the Western Aleutians to provide coverage for the initial location of earthquakes elsewhere in the Pacific.

The immediate result of implementing this data circuit has been to reduce the response time of PTWC from an average of 37 minutes after the activation of alarms to an average of 22 minutes, a 40Δ operational improvement in response time.

Tsunami Data Acquisition

Two new tide stations have been added to the Hawaii Regional Net, one at the entrance to Pearl Harbor and the second at Mahukona on the northwest coast of the island of Hawaii. In addition, seventeen solid-state tide transmitters have been purchased for installation at various U.S. tide stations in the Pacific. These units operate on a battery backup to ensure continued operation during any outages of local power. To date, twelve units have been installed at Pacific field stations.

The four satellite telemetry tide stations installed in South America in 1981 have not proven operational due to continuing maintenance problems. The instrumentation from these stations has been returned to the United States, or is in the process of being returned to the U.S., for maintenance and further development. Two of these units have been returned to PTWC and restored to full operational status. To ensure success prior to final field deployment, one of these units has been installed at Johnston Island for extensive field testing and evaluation. These units can be interrogated from PTWC to provide real-time tide data via the Geostationary operational Environmental Satellite (GOES). Deployment to strategic areas will be implemented as soon as the reliability of the systems are proven and arrangements can be coordinated to provide continuing long-term maintenance.

Four additional satellite telemetry systems have been purchased for the tsunami program. These units, though non-interrogating, can be used as tide data collection platforms with data transmission on an hourly basis, or programmed as event detectors to begin data transmission on an emergency GOES channel as soon as a tsunami impacts at that station. Deployment of these systems is planned for South America by the end of 1984.

Tsunami Evaluation

In 1983, PTWC initiated efforts to develop a predictive tsunami forecast capability by analyzing the distribution and impact of historical tsunamis, correlating these historical data with major seismic gaps having the potential to be tsunamigenic, and developing threshold tsunami run-up values of predicted impact for an area. Initial efforts have concentrated on the Hawaiian Islands, partly because of the data base available and partly because tsunami impact on Hawaii is indicative of most Pacific-wide tsunamis.

Modified Watch/Warning Procedures

At the ITSU-VIII Session in April 1982, the United States proposed implementation of modified procedures by PTWC to issue Watches and Warnings on a time-stepped basis, with the initial Warning to cover an area within three hours tsunami travel time of the epicenter. This proposal was approved as Resolution ITSU-VIII.3, with implementation to be by October 1, 1982.

In developing the procedures for implementation of this Resolution, PTWC encountered previously unrecognized operational problems, specifically in the issuance of a Warning for any region of the Pacific using only earthquake information without any wave confirmation. The implementation of Resolution ITSU-VIII.3 was accordingly delayed until March 1, 1983, and modified to issue a Watch on a time-stepped basis while still reserving utilization of a Warning status contingent on wave confirmation. The procedures presently being implemented consist of PTWC issuing an initial Watch for an area covering a six-hour tsunami travel time, with the area within a three-hour travel time receiving special designation for possible urgent action. The Watch area is expanded hourly until the Watch can be cancelled or upgraded to a Warning.

A modification to Resolution ITSU-VIII.3 was submitted to the Intergovernmental Oceanographic Commission with the request that the new procedures be considered and evaluated by participants at the ITSU-IX Session.

Automation

The development of a parallel on-line seismic processing capability at PTWC is still continuing. Differences in computer operating systems between ATWC and PTWC and in computer graphics hardware require a lengthy conversion of software between the two Centers.

Computer hardware purchases have included the installation of a second Data General S/230 minicomputer at PTWC to provide a reliable internal backup capability.

B. ALASKA TSUNAMI WARNING CENTER

West Coast Responsibility

In the summer of 1982, the ATWC's area of responsibility was expanded to include the issuances of tsunami watches and warnings, to the west coasts to Canada and the United States (U.S.), for possible tsunamigenic earthquakes occurring in those regions. These are issued to British Columbia, Washington, Oregon, and California, and are based on seismic data. New procedures were required and implemented in the ATWC's operational procedures. The main features of the procedures relate to the issuance of a warning based on the magnitude of the earthquake. If an earthquake occurs in west coast areas, with a magnitude greater than 6.75 and less than 7.5, an earthquake information message will be disseminated to the ATWC's recipients. The tide site's data, near the epicenter, will be requested by the ATWC to ensure that a tsunami was not generated. This tide data monitoring is necessary for threshold tsunamigenic earthquakes. If the magnitude is 7.5 or greater, a warning will be issued and the tide site's data evaluated. A warned area includes those places that are within 3 hours of water wave travel time from the epicenter. The appropriate remaining areas, outside the warned area, are placed in a watch status. Tide gage data are obtained from 6 sites, along the west coasts of Canada and the U.S., via teletypewriter and telephones. Upon confirmation that a tsunami has been generated, the previously designated watch areas are upgraded to a warning status.

Automation

The ATWC has implemented an automated system to replace manual procedures used in providing tsunami warning services for their areas of responsibilities. This system is also used to transmit processed and collected data rapidly to other U.S. agencies and countries. Earthquake parameters are automatically computed for alarm events, using a minicomputer and telemetered data from 32 real-time seismic sites, located in Alaska, the continental U.S., and Hawaii. The data are continually monitored for an event, and if detected, data are saved on a disk and used to automatically recompute the earthquake's parameters. The computational results and data are displayed, and easily refined by duty personnel. The parametric results can easily be refined. Although the system has been implemented and used for more than 50 alarm events, various parts will be improved in the future. A paper on this system was presented at the IUGG Conference in Hamburg in August 1983, and is currently being prepared for publication.

Instrumentation

Equipment maintenance, improvements, and additions are a continuing function. Main equipment replacements, at both the Center and field sites, included: a radio-alarm system to alert

duty personnel during those times that the station is not manned; numerous seismic and tide recording equipment for displaying real-time data; and, data transmitters installed at all tide sites. Main equipment additions were computer peripherals, such as, a printer, disk, and VDT's. Yearly preventative maintenance is performed for 17 remote seismic and 8 remote tide sites. These sites are visited each year, and as soon as possible after equipment failure, to ensure a continuous data flow to the Center.

Communications

Advanced teletypewriter communication equipment has replaced the mechanical teletypewriter equipment for disseminating messages. This equipment consists of a video display terminal (VDT) and receive-only printer. These are quieter, smaller, faster, and more dependable than the mechanical equipment. They also eliminated the requirement to generate 5 level Baudot paper tapes prior to message dissemination. Additionally, computer generated messages are easily transmitted to the VDT for dissemination.

During the past two years, many daily and monthly communication tests have been conducted to monitor the dissemination and reception of tsunami information. These tests are via teletypewriter, National Warning System, Alaska Warning System, and a VHF radio. The test results show the communication problem areas that need improvement. Teletypewriter commuications with the U.S. west coast is an area that requires improvement. Problems in this area have been, and are being corrected as they surface.

Community Preparedness

A three part community preparedness effort, concerning the earthquake and tsunami hazards, is another continuing program. This includes: visits to distant cut-lying communities from Ketchikan to Nikolski; visits to local group facilities and schools; and, tours through the ATWC facilities. The main purpose of this program is to educate the public to help themselves if they are caught in the middle of a violent earthquake and/or tsunami. The presentations given during these visits include: a slide show; discussions concerning the effects of earthquakes and tsunamis; the ATWC functions; and, a question and answer period. In addition to the outside presentations, the ATWC facilities are opened to the public each Friday from 1-3 pm, and infrequently on other days. These tours are conducted by the staff members.

C. WATER LEVEL TELEMETRY SYSTEM

The National Ocean Service (NOS) has continued to automate data collection at long-term tide stations in the Pacific. The NOS has installed Water Level Telemetry System (WLTS) units at NOS tide

stations located in California, Oregon, Washington, Alaska, and Hawaii. The WLTS is a data collection and distribution system. The WLTS collects the water level and observer data at the remote site and, upon interrogation, transmits the data to NOS headquarters in Rockville, Maryland. WLTS will accept data from either pressure or float driven sensors as the primary input source. The data are made available to the National Weather Service (NWS) Automated Field Operating System (AFOS) for further dissemination to all NWS offices. One of the key features of the system allows the Alaska Tsunami Warning Center or the Pacific Tsunami Warning Center to command a station to go into a fast data sample scan either on an immediate basis or on a predetermined start and stop time. These data are then collected by the Master Computer in Rockville, Maryland and disseminated to the Warning Center. WLTS units are installed at Port San Luis and San Francisco, California; Port Orford, Oregon; Toke Point and Neah Bay, Washington; and Kahului, Hawaii. The NOS plans to reinstall the WLTS station at Santa Monica, California, when the pier, destroyed in January 1983, is rebuilt. NOS also plans to install a WLTS pressure system at Anchorage, Alaska, during the summer 1984. As presently designed, the WLTS will not be expanded to additional sites.

D. RESEARCH AND DEVELOPMENT

Tsunami research in the United States may be conveniently divided between observational studies that involve the acquisition of tsunami measurements and theoretical studies that involve analytical or numerical modeling of the tsunami processes. During the past four years progress has been made by United States scientists on both fronts. Additionally, efforts were undertaken to focus U.S. tsunami research by publishing a national research plan, bridge communication with Japanese tsunami specialists, survey the May 26, 1983 Japanese tsunami, and compile a tsunami data base.

Observational Studies

Measurements of the tsunami resulting from a Mexican earthquake on March 14, 1979 was made in 3000 m water depth off Baja, California. These data demonstrated that the technology is available to detect tsunamis in the open ocean. Another observational program has been conducted off the Galapagos Islands with instruments in 3000 m, 10 m, and 1 m water depths to measure the shoaling transformation of tsunamis. These internally recording instruments have recorded from a Central American earthquake on June 19, 1982. Self-contained shore recording instruments have been developed to supplement tide gage information in the Hawaiian Islands. Also, an observational team has been created to measure and photograph various tsunami effects in the Hawaiian Islands. This team has practiced its effectiveness on local storms. These observational programs have been supported by the National Science Foundation and the National Oceanic and Atmospheric Administration.

Theoretical Studies

Generation studies have included the examination of seismic data to differentiate between tsunamigenic and non-tsunamigenic earthquakes. A new scale based upon long period seismic waves is being evaluated for use in the tsunami warning system. Also, seismic data are being analyzed to estimate the faulting mechanism relative to tsunami generation. Numerical models of tsunami generation have been constructed and used to simulate major tsunamis in South America. These models utilize realistic bottom deformations in both time and space scales. The results indicate that the duration of rupture greatly influences the transfer of energy from the earthquake to the tsunami.

Propagation studies have continued utilizing linear theory to describe reflection, refraction, scattering, and conversion to trapped waves. Several techniques are available for modeling this area of tsunami evolution such as finite element methods and finite difference methods. All techniques can accommodate variable grid scales and can simulate transient pulses of energy. Several areas have been studied such as South America, American Samoa, and the North Pacific Ocean.

Run-up studies have been conducted in a hindcast mode to estimate tsunami risk. Usually linear numerical models are used to interpolate between historical data points. Progress in non-linear effects was made in a study of the harbor response to transient waves and in coastal areas by several investigators. Also, the three-dimensional effects of tsunamis over variable depth are being investigated with numerical and analytical models.

Studies to determine the risk of the tsunami hazard have been conducted to guide management of the coastal zone. These studies have enabled researchers to examine historical tsunami data and derive estimates of resonance intervals and maximum shoreline threat.

U.S. - Japan Workshop

In May 1983, the National Science Foundation sponsored a U.S.-Japan Tsunami Workshop in which 10 U.S. scientists and 16 Japanese scientists participated. The purpose was to promote interchange of ideas and research in progress between U.S. and Japanese scientists and engineers working in the field of tsunamis.

National Academy of Engineers Study on Japanese Tsunamis

In July 1983, the National Academy of Engineers sent a survey team to Japan and Korea to evaluate damage from the May 26, 1983 Japanese tsunami. A report is due by January 1984.

THRUST

The Office of U.S. Foreign Disaster Assistance (OFDA) of the Agency for International Development has commissioned a pilot study known as THRUST (Tsunami Hazard Reduction Using System Technology). The THRUST project team is made up of personnel from OFDA, three elements of NOAA, and two scientific research firms. The goal is to demonstrate that regional systems can be assembled, using existing technology, and integrated into established disaster warning and relief infrastructures in developing nations. The program is based on an earlier study (Bernard et al., 1982) showing that such systems are technically feasible.

Remotely located seismic and water level sensors instantly notify GOES when stronger-than-threshold signals are received. The GOES system automatically interprets the notification and sends pre-determined messages to local authorities and to PTWC alerting them to a potential tsunami. The data stream from tide gauges begins as local authorities decide on the appropriate response As the data continues, local authorities can update their assessments in real-time and PTWC can both evaluate the need for Pacific-wide action and archive the data for later study. In this former instance, PTWC will actually be receiving data sooner than it would from its own system. Note that the GOES-based system does not supplant the human decision maker in any way.

One of the keystones of OFDA projects is the transfer of technology to the host country. Thus the purpose of THRUST is not to build and maintain a warning system for the threatened nation. Instead, the goals are to show that such a system can be built, to work with the host government to integrate the technical system into its disaster control structure, and to train in-country personnel in the operation and maintenance of the system. Each phase of THRUST, then, will be conducted in conjunction with personnel from the host country. In this way the technology behind THRUST can be demonstrated to other tsunami-prone (and, indeed, geophysical hazard-prone, in general) nations, while concurrently enhancing the technological capabilities of the nation in which the demonstration is conducted. Successful completion of the THRUST pilot project will not only enhance the tsunami protection of the host country but will, by adding additional input to PTWC, improve the protection of the entire Pacific community.

International Tsunami Information Center (ITIC)

The United States, recognizing the importance of the International Tsunami Information Center to the Pacific Tsunami Warning System, and to ITSU, has continued to provide support in the last two years in moderately increasing levels. Presently United States pays the salaries of the ITIC Director and the Secretary and, through a contractual arrangement, is providing the

services of a full-time Librarian. In addition, United States provides the logistical support that enables ITIC to fulfill its mandate. The physical space that ITIC occupies in Honolulu was expanded by approximately 75Δ in September 1983 making appropriate additional office space available for an Associate Director and visiting scientists. Funds have now been earmarked to provide ITIC with a computer/word processor which will facilitate office automation, library cataloging, and publication preparation. Thus, United States is continuing its support which enables ITIC to perform most of its basic functions, but looks also to the international community for additional support that will enable ITIC to fulfill more adequately its mandate. Full details on the ITIC activity are provided by the Director's Report.

World Data Center-A (Tsunamis)

WDC-A for tsunamis has continued to add to its holdings of tsunami related mareograms, bathymetric data, tsunami related photographs, seismic data and digital data about the occurrence and effects of tsunamis. This latter has been our major effort of the last several years. Also as part of the THRUST project to install a demonstration satellite linked regional tsunami warning center in Chile, WDC-A is compiling detailed data for Chilean tsunamis and preparing a general use Pacific tsunami map. The current status of each of these activities follows:

1. Tsunami-related Mareograms. WDC-A's collection has grown to more than 3000 records for nearly 300 tsunamis. The 1982 holdings were 2,250 and 258, respectively. A recent acquisition of 21 digitized records from Chile is an important addition to our collection. In turn we were able to supply Chile with copies of about 38 additional mareograms from early tide stations in Chile which they did not have.

2. Photographs. Our collection has grown modestly from 650 to 687, mostly by the addition of some photographs from the May 22, 1960 Chile tsunami. This collection has been advertised as part of KGRD-20 "Natural Hazards Photograph Collection." The inventories are kept on digital files according to subjects of the pictures.

3. Seismic Data. The principal source for seismic data are the seismograms from the World Wide Standard Seismographic Network augmented with other stations including the USSR National Network for larger earthquakes (magnitude 7.5 and larger). Also, the epicenter, focal mechanism and magnitude data are routinely acquired from the USGS National Earthquake Information Service.

4. Bathymetric Data. WDC-A has the U.S. coastal bathymetry collected by the U.S. Coast and Geodetic Survey and its successor organization, the National Ocean Survey. This amounts to 32 million observations from 1930 to current. These

data are digital and can be provided as area searches, evenly spaced grids or profiles suitable for run-up models.

Additionally, the Data Center has the Synthetic Bathymetric Profiling System, SYNBAPS, which consists of 5-minute grids (2,487,600 points) or 5-minute longitude by meridional parts (latitude) consisting of 3,489,066 points. This is potentially useful for computing trans-oceanic travel times.

5. Digital Event Data. The core of this file is a data base of 1473 Pacific tsunamis compiled by Doak Cox of the University of Hawaii. The original file had many blank fields, particularly for earthquake epicenter, magnitude, and effects. We have more than doubled the listings of localities which have experienced the tsunamis. We have added information on fatalities and damage. The destructive tsunami listing now consists of information on fatalities and damage. The destructive tsunami listing now consists of information on 168 tsunamis dating from 684 A.D.

6. Pacific Tsunami Map. Using the event data file at least for the tsunamis of this century which have associated epicentral/source regions, we will prepare a multi-color map (for general use). It will display source regions and local remote wave heights and effects. Some information will be contained in inserts for great Pacific-wide tsunamis. Photographs will be used to illustrate the impacts. There will be a table on the lower margin giving specific information on location, magnitude, wave heights, destruction and fatalities. It will also give key references.

USSR

The Tsunami Warning Service

In accordance with the USSR administrative structure the tsunami warnings in the Pacific, the Sea of Okhotsk and the Sea of Japan coastal areas are given at present to the population and organizations by three independable centres - Petropavlovsk-Kamchatsky, Yuzno-Sakhalinsk and Vladivostok - on the basis of observations for under-marine earthquakes and changes of the sea level.

Seismic stations Yuzno-Sakhalinsk, Petropavlovsk-Kamchatsky and Kurilsk participate in the operation of the Tsunami Warnings Service. Arrangements are being made to involve into the Service seismic stations at Severo-Kurilsk and Vladivostok.

Seismic stations registering submarine earthquakes, determine the locations of earthquakes and their intensity. For the seismic-active areas in the Pacific critical values of intensity of earthquakes have been established, which can produce tsunami dangerous for coastal areas of the Far East.

Observations for changes of the sea level are also organized beginning with declaration of the tsunami threat in a number of coastal points situated along coastal areas of the Pacific, the Sea of Okhotsk, and the Sea of Japan.

Observational data for under-marine earthquakes and observational data for changes of the sea level beginning with declaration of tsunami threat are transmitted to the above mentioned tsunami warning centres (Petropavlovsk-Kamchatsky, Yuzno-Sakhalinsk, Vladivostok) through wire and radio channels.

In practice of issuing tsunami warnings it is used seismic method, which provides observational data processing and making a decision about declaration of tsunami warnings within 10 minutes after beginning of earthquakes with the epicentrum located up to 1000 kilometres.

Investigations are carried out to specify features of submarine earthquakes, which can produce tsunamis. At the same time the possibilities of using hydrophysical method investigated for tsunami prediction on the basis of registration of changes of the sea level offshore.

At present to improve seismic service in the USSR work is being done to further develop software for automatic processing of seismic records in real time as well as modifications of using seismographs.

Sending warnings to the population and organizations within tsunami-dangerous areas on the Far Eastern coast are carried out in accordance with schedules developed for every area.

Tsunami tests are in practice within various areas of the Far Eastern coast. Tests are made to determine the transmission times of tsunami messages through using communication channels.

Tsunami Investigations

The investigations in the tsunami problem during the intersessional period have been carried out by a number of research institutes and organizations of the Akademy of Sciences of the USSR, the USSR State Committee for Hydrometeorology and Control of Natural Environment (before - Hydrometeorological Service of the USSR) and some other institutions.

Earthquakes and tsunami investigations have been carried out by statistical methods on the basis of the registered under-marine earthquakes and tsunami data. Produce tsunami processes have been studied in dependence of ocean bottom motions characters accompaning with under-marine earthquakes. Estimation of tsunami have been carried out which arise in result of under-marine landslides or under-marine volkano eruptions.

Investigations have been carried out in the problem of tsunami spreading in the ocean, of tsunami behaviour on the shelf and of waves going out to the sea shore. Research has been continued in the field of tsunami division into districts.

The results of these investigations have been published in scientific printing, some works at present are in publishing houses and will be published.

Interaction with the International Tsunami Warning System in the Pacific

For interaction between USSR tsunami warning service and the International tsunami warning system in the Pacific, cable link Tokyo - Khabarovsk is issued.

In the 1983 volume of the messages, which are within the problem, connected with the International Tsunami Warning System in the Pacific and broadcasted through international communication channels, become practically twice as much as compared with the 1982 (see the table):

	The number of messages		The messages travel time through communication channels to Khabarovsk	
	1982	1983	Minimum	Maximum
Honolulu	139	240	3 minutes	15 minutes
Palmer	18	25	10 "	40 "
Tokyo	29	45	1 "	2 "
Hong Kong	140	327	3 "	25 "
In all:	326	637	3 "	25 "

To some extent increasing of tsunami dummy tests, issued by the Pacific Tsunami Warning Centre (PTWC) at Honolulu, have been marked: 16 tests in the 1982, 24 tests in the 1983.

In the 1983, 8 tsunami dummy tests have been received from the centre Palmer.

List of National Contacts of ICG/ITSU

The following is a list of National Contacts of ITSU members on file in the ITIC office. Please inform ITIC if there are any changes.

CANADA

Mr. W. J. Rapatz
Regional Tidal Superintendent
Institute of Ocean Sciences
Dept. of Fisheries and Oceans
P. O. Box 6000
Sidney, B. C. V8L 4B2, Canada

CHILE

Captain Humberto Garcia Trivelli
Director
Instituto Hidrografico de la Armada
Casilla 324
Valparaiso, Chile

CHINA

Mr. Luo Yuru
Director
National Bureau of Oceanography of the
People's Republic of China
Beijing, China

COLOMBIA

Capitan de Fragata Ernesto Cajiao
Secretario General
Comision Colombiana de Oceanografia
Apartado aereo No. 28466
Bogota, D.E., Colombia

COOK ISLANDS

Commissioner H. R. Melrose
Police National Headquarters
P. O. Box 101
Rarotonga, Cook Islands

ECUADOR

Calm. Fernando Alfaro Echeverria
Director
Instituto Oceanografico de la Armada
Casilla 5940
Guayaquil, Ecuador

FIJI

Mr. A. Rahiman
Director, Mineral Development
Mineral Resources Department
Private Mail Bag
Suva, Fiji

FRANCE	Dr. M. Jacques Recy Directeur de la Recherche Office de la Recherche Scientifique et Technique Outre-Mer B.P. A5 Noumea Cedex (Nouvelle Caledonie) France
GUATEMALA	Ing. Carlos Rodolfo Martinez Giron Chief of Seismology Section INSIVUMEH 7a. Ave. 14-57, Zona 13 Guatemala, Guatemala
INDONESIA	Dr. Aprilani Soegiarto Directeur Lembaga Oceanologi Nasional of the Indonesian Institute of Sciences Kompleks Bina Samudera P. O. Box 580 Dak Jakarta, Indonesia
JAPAN	Dr. Norio Yamakawa Head, Seismological Division Japan Meteorological Agency Ote-machi, Chiyoda-ku Tokyo, Japan 100
KOREA (REPUBLIC OF)	Mr. Myong Bok An Director of Weather Analysis Central Meteorological Office 1 Songweol-dong, Ching-ku Seoul, 110 Korea
MEXICO	Lic. Ma de los Angeles Lopez-Ortega Ministro Consejero Encargada de Negocios a.i. UNESCO Delegacion Permanente de Mexico 1, Rue Miollis 75732 Paris, France
NEW ZEALAND	Mr. Norman M. Ridgway Dept. of Scientific & Industrial Research New Zealand Oceanographic Institute P. O. Box 12-346 Wellington North, New Zealand
PERU	Contralmirante Jorge A. del Aguila Sanchez Direccion de Hidrografia y Navegacion de la Marina Casilla Postal No. 80 Gamarra No. 500 Chucuito, Callao, Peru

PHILIPPINES	Mr. Conrado M. Santos Chief Geophysicist Physical Science Division Bureau of Coast & Geodetic Survey 421 Barraca St. San Nicolas, Manila, Philippines
SINGAPORE	Mr. Paul Lo Su Siew Director Meteorological Service Singapore P. O. Box 8 Singapore Changi Airport Singapore 9181, Republic of Singapore
THAILAND	Commander Thanom Charoenlaph Hydrographic Department Royal Thai Navy Bangkok 6, Thailand
UNITED KINGDOM (HONG KONG)	Mr. Patrick P. Sham Royal Observatory, Hong Kong 134A Nathan Road Kowloon, Hong Kong
USA	Mr. Richard H. Hagemeyer Director National Weather Service, Pacific Region P. O. Box 50027 Honolulu, Hawaii 96850
USSR	Dr. B. P. Khimitch Chief, Arctic and Antarctic Department USSR State Committee for Hydrometeorology and Natural Environmental Control 12, Pavlik Morozov Per. Moscow 123376 USSR
WESTERN SAMOA	The Superintendent Apia Observatory Private Mail Bag Apia, Western Samoa
Director, ITIC	Dr. George Pararas-Carayannis Director International Tsunami Information Center P. O. Box 50027 Honolulu, Hawaii 96850 USA (Cable Address: ITIC HONOLULU)

Chairman, ICG/ITSU Mr. Norman M. Ridgway
Dept. of Scientific & Industrial Research
New Zealand Oceanographic Institute
P. O. Box 12-346
Wellington North, New Zealand

IGOSS Launches Sea Level Pilot Project

Commencing in the early part of this year, the University of Hawaii, under the direction of Professor Klaus Wyrtki, has started a pilot project for the operational exchange of mean sea level data in the Pacific Ocean. The project is operated as an IGOSS Specialized Oceanographic Centre for the IGOSS Sea Level Pilot Project (ISLPP); receives mean sea level data from participating countries in the Pacific; prepares the monthly sea level charts and disseminates these products back to participating countries and scientists.

If successful, the project will be extended into other areas of the world's oceans. On the longer time scale, interest in mean sea level variations will also generate increased emphasis for the establishment of the IOC global tide gauge network.

Operational Sea-Level Stations Published

The Permanent Service for Mean Sea Level (PSMSL) is a world data center for mean sea level data established at Bidston, United Kingdom since 1933. The Center co-operates directly and receives the support of the IOC. PSMSL has collected, checked and published monthly mean sea levels. Data are received after a delay which varies from one to several years, from a network of national authorities, principally hydrographic departments, mapping agencies and oceanographic data centers. PSMSL has conducted a survey of all past, present and potential suppliers of sea-level data. The objectives were to establish details of existing gauges and to determine which authorities would be willing to cooperate in more rapid data transmission and in the installation of new equipment.

A copy of the questionnaire entitled "International Survey of Sea-Level Measurements" were sent to 204 addresses in 98 countries. From the responses of the returned questionnaires, a publication consisting a list of Running Gauges in 1982 by countries, station names, along with positions of stations gauge types ... etc. The publication is entitled "Operational Sea-level Stations". It is published by UNESCO-IOC under the technical series.

Full details of the replies to the questionnaire are available from PSMSL, and maps of gauges reported to be functioning in a particular area can be prepared on request. For detail, write to:

PSMSL
Bidston Observatory
Birkenhead
Merseyside L43 7RA
United Kingdom

NATIONAL AND AREA REPORTS

Tsunami Field Exercise

A Tsunami Field Exercise was held on Oahu, Hawaiian Islands on Tuesday, October 23, 1984 sponsored by the U.S. Federal Emergency Management Agency (FEMA), the U.S. Corps of Engineers, the Hawaii State Civil Defense and the Joint Institute of Marine and Atmospheric Research. Dr. George Pararas-Carayannis, Director of ITIC was invited to attend and to give to the participants, along with other instructors, the benefit of his experience in conducting post-tsunami surveys of a stricken area. The tsunami field exercise was held along an uninhabited beach area of Bellows Air Force Station in Waimanalo. The emphasis of the exercise was placed in measuring accurately tsunami inundation parameters, such as runup, flooding and coastline penetration using simple surveying devices and techniques. The exercise was organized and conducted by George D. Curtis of JIMAR.

Tsunami Warning Exercise for Canada

An exercise of the Canadian portion of the Tsunami Warning System was conducted on 26 July 1984 involving the Alaska Tsunami Warning Center (ATWC) at Palmer, Alaska, Emergency Planning Canada (EPC) and the U.S. Federal Emergency Management Agency (FEMA). The exercise was initiated by ATWC in Palmer via NAWAS Communication network to British Columbia Canadian authorities in accordance to the NOAA operative plan.

ATWC prepared and sent scenario messages initiating the exercise in accordance to EPC requirements. The messages generated realistically portrayed both content and timing of what might be expected in actual event messages.

The exercise helped to determine small problems which exist in the tsunami message fanout procedures. As a result of the exercise revisions of the procedures have been recommended which will rectify any existing problems.

Captain Eduardo Barison Completes Term of Office

Captain Eduardo Barison, Director of the Hidrographic Institute of the Chilean Navy for the last two years has completed his term of office at the Institute as of the end of October 1984, and has been transferred to another position. Captain Humberto Garcia Trivelli is the new Director of the Hidrographic Institute and has overall responsibility for the Tsunami Warning System in Chile. The tsunami scientific community enjoyed working in the last two years with Captain Barison who maintained and strengthened the links of technical and scientific cooperation of his Institute with the rest of the Pacific.

Tsunami Stations Inspection

The Pacific Tide Party personnel completed the inspection of the following stations:

Adak, Alaska	June 2, 1984
Unalaska, Alaska	June 6-9
Sand Point, Alaska	June 10
Sitka, Alaska	June 18
Yakutat, Alaska	June 29-30
Kodiak, Alaska	July 12
Seward, Alaska	July 15-18

ANNOUNCEMENTS

Tsunami Workshop to be Held in Sidney, Canada

At the 9th Session of the International Coordination Group Conference on the Pacific Tsunami Warning System in the Pacific in March 1984 in Honolulu it was decided that a Tsunami Workshop should be held concurrently with the ITSU-X meeting in Victoria, Canada. Approximately 3 days, July 29, 30, 31, 1985 have been devoted to the workshop with half of the third day devoted to a field trip. ITIC, in close coordination with the IOC Secretariat, with the Canadian coordinator, Mr. Syd Wigen, and with the Chairman of ITSU, has developed an intensive workshop schedule on the different aspects of the Tsunami Warning System, as well as informal discussions where the participants will be encouraged to state their tsunami problems encountered in their own countries, and how ICG/ITSU can best help them.

The objective of the workshop will be to bring to each participant a better awareness of the tsunami problems in his/her own state; what actions may be initiated within each state to mitigate the tsunami hazard; and how each ITSU Member State can contribute to the protection of the other Member States. It is not known at this time what funding will be made available to participants who attend this workshop. Interest in such participation should be expressed by writing to the Secretariat of IOC with copies to ITIC, and to the Chairman of ICG/ITSU. Prerequisites for candidature in participating in this workshop will include a technical involvement by the applicant in some aspect of tsunami mitigation in his own state, preferably some capacity or responsibility to initiate and implement policies. A written resume would be required. An outline from each applicant on what he sees as tsunami problems and hazards within his own state, with particular emphasis on what he would like to see addressed during the workshop. Lastly, a good working knowledge of the English language is necessary. Participants are encouraged to bring maps and charts and other materials which they consider crucial to their tsunami prone coasts, records of tsunami history in their own country, and a listing of tide and seismic stations in their country. Also, it would be desirable to know how records are being archived or fitted into their warning system.

Additional information on the workshop will be published in future issues of the Tsunami Newsletter and will be provided to the National Contacts of ICG/ITSU as plans formulate.

Call for Papers for the Journal of the Tsunami Society

The Tsunami Society published recently the second issue of its Journal and will be going to press with the third issue in the very near future. Members and non-members are invited to submit tsunami related papers to the Editor of the Journal of the Tsunami Society for

future issues. The Journal will accept tsunami related papers which will be subject to peer review prior to publication and will be returned to the authors for final editing and preparation of camera ready copies. Format and specifications for the Journal have been published in the Journal itself. Rate charges for publication in the Journal of the Tsunami Society are $50.00 per page. Please submit papers to : The editor, Tsunami Society, P. O. Box 8523, Honolulu, Hawaii 96815, USA.

PTC'85 to be Held in Honolulu, Hawaii

"Telecommunication for Pacific Development: Toward a Digital World" is the theme of the upcoming Pacific Telecommunication Council Conference of 1985. This conference is scheduled to be held January 13-16, 1985 in Honolulu. Papers presented will relate to various aspects of adapting digital technology to voice and data communications and broadcasting focusing on Asia, the Pacific and the Americas.

First Biennial Conference of the Canadian Hydrographer's Association is scheduled in April, 1985

The above mentioned conference will be held in Halifax, Nova Scotia from April 16th to 19th, 1985. The theme of the Conference will be "Hydrography and Technology in the mid-80's (How well are they working togetherμ)". Emphasis will be placed on hydrographic data collection, data manipulation and presentation of information. Hands-on demonstrations of acquisition systems from survey launches will be included as part of the technical program and will provide a unique opportunity for government agencies and private industry to show their wares.

Breakwater Workshop to be held

A Floating Tire Breakwater Workshop will be conducted in Niagara Falls, New York, on 7-9 November 1984. For more information please contact:

Laurie Broderick
Waterways Experiment Station (WES)
U.S. Army Corps of Engineers
P.O. Box 631
Vicksburg, MISS 39180
Phone: (601) 634-2063

Documentation of Earthquake Algorithms Available

The above mentioned report is available from the World Data Center A for Solid Earth Geophysics as Report SE-35. It was compiled by E.

R. Engdahl of the U. S. Geological Survey. It contains summary information on important algorithms available to the seismology community as of July 1984 for optimally estimating various earthquake parameters related to source location, source retrieval and synthetic seismograms. The algorithms in the report was submitted by seismologists from 19 organizations in 11 countries.

To order this report, write to:

National Geophysical Data Center
NOAA, Code E/GC4
325 Broadway
Boulder, CO 80303
Price: U.S. $6.00 (U.S. $7.00 foreign)

Those who would like to have algorithms distributed by WDC-A, can also write to the above address for information.

PACON 86

The second Pacific Congress on Marine Technology (PACON 86) is planned to be held at the Princess Kaiulani Hotel, Honolulu, Hawaii on March 24-28, 1984. The technical program will be similar to that of PACON 84. However, some new sessions on marine recreation, marine cities, OTEC-aquaculture and marine technology education have been planned. The technical program will be coordinated by Drs. Christopher N.K. Mooers and Narendra K. Saxena.

ABSTRACTS

Some Tsunami Characteristics Deducible from Tide Records

William G. Van Dorn

After an initial 40-hour "diffusion" period, the time decay of tsunami variance was found to be uniformly exponential for 28 events among eight Pacific tide stations. These results essentially confirm Munk's acoustic decay hypothesis except that the decay (e-folding) time (22 h) more nearly equaled the ocean's normal mode transit time (21 h) than Munk's mean collision time (14 h).

Relative tsunami energy, obtained by extrapolating exponential decay back to t=0, was found to be similarly ranked among tsunamis at all stations and roughly proportional to seismic energy. A total energy estimate for the tsunami of 9 March 1957, obtained by correcting the observed energy decay at Wake Island for instrument and island response, provided normalized total energy estimates for all tsunamis that were consistent with independent estimates by Kajiura and by Aida.

Similarities between power spectra computed from these time series suggests that station response is primarily linear normal-mode forcing of the continental shelves by the isotropic tsunami spectrum in deep water, rather than resonant excitation of trapped edge waves on the shelves.

[Journal of Physical Oceanography, Vol. 14, No. 2, February 1984, pp. 353-363]

Statistical Data on the Character of Tsunami Wave Runup on a Beach

R. Kh. Mazova, E. N. Pelinovsky, S. L. Soloviev.
Institute of Applied Physics of the Academy of Sciences
46 Uljanov Street, 603600 Gorky
USSR

Using the tsunami catalogues by Soloviev S. L. and Go C. N. and related data, tsunami waves are divided into those climbing a beach with breaking and without. It is shown that flooding of a beach without breaking is typical of most tsunamis. It is ascertained that the probability of breaking of a wave increases with increasing its height. A conclusion is made that the character of tsunami wave runup should be taken into account in calculation of the tsunami resistance of coastal buildings. Graphs of recurrence of different types of tsunamis are plotted.

Report on Methodologies for Collection and Dissemination of Tsunami Data - Earthquake Engineering

Dennis W. Moore and George D. Curtis
Joint Institute of Marine and Atmospheric Research

The prior report, covering the development and implementation of the monitoring program and design of the solid state gage, is summarized. The remaining tasks are outlined: fabrication and tests of final equipment items; expansion of the monitoring program; and publication of a manual on tsunami surveys and a paper on the monitoring program.

The final development of a 6" diameter lab test system and a 4" field test prototype is described and illustrated in detail. Electronic factors, physical factors, and tests are discussed and results presented. Both units performed successfully in the fast-sample mode needed for tank tests.

Recommundations for a final version, are made, including smaller diameter, lithium batteries, finalized circuitry and time constants, and deployment planning.

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The Tsunami mode of a flat earth and its excitation by earthquake sources

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Tsunami generation by earthquakes in a flat, isotropic, elastic, vertically stratified earth underlying a uniform-depth, incompressible ocean can be studied in terms of the tsunami normal mode of the combined ocean - solid earth system. We derive, in a way that demonstrates their natural extension from traditional approaches to tsunami theory, the equations and boundary conditions governing the tsunami mode displacement and stress eigenfunctions, then solve the excitation problem by a variational method. This leads to a straightforward expression for the far-field tsunami displacement due to a point moment tensor source in the solid earth. Numerically computed spectra and waveforms reveal clearly the dependence of the far-field tsunami on the source depth, duration, moment and mechanism.

[Journal of Geophysical Research, Vol. 77, 1984, pp. 1-27]

Tsunami generation: a comparison of traditional and normal mode approaches

Robert P. Comer

Techniques to model tsunami generation by earthquakes may be divided into two broad categories, according to whether the ocean and solid earth are fully or partially coupled. The former category includes normal mode techniques while the latter is comprised of more traditional approaches, including those in which the hydrodynamic equations for the ocean are solved subject to an inhomogeneous time-dependent boundary condition at the ocean floor. We compare representatives of each approach, using a solution for the flat earth tsunami mode excitation due to a point momemt tensor earthquake source and amore traditional model in which the ocean floor boundary condition is derived from the static response of an elastic half-space to a point moment tensor. The results are nearly identical and extend to finite sources according to linear superposition, thus establishing the practical equivalence of the two conceptually divergent techniques and assuring the general validity of models with partial coupling.

The Soviet Geophysical Committee of the Academy of Sciences of the USSR has recently published a monograph entitled "Tsunami Wave Generation and Run-up" in celebration of the 100th Anniversary of the International Geophysical Research. The following is the table of contents of the monograph and abstracts of each paper presented:

Tsunami Wave Generation and Run-up

Academy of Sciences of the USSR, Moscow, 1984.

Table of Contents:

Some problems of tsunami wave theory (Cauchy - Poisson problems)

Chepinoga, M.M.; Belozerov, B.S.

Plane linear problems on wave motions of viscous incompressible liquids of an infinite or finite constant depths, which are caused by specified initial perturbations of the ice-liquid interface and by normal stresses on the latter, as well as by underwater explosions, are considered. Account is taken of the ice thickness, rigidity and mass under the assumption of a partial liquid slippage along the solid wall. To solve the problems, we use the integral transforms of Fourier and Laplace -- Carson, algebraic identity (to define the

originals), stationary phase method and integration by parts (to evaluate the Fourier integrals under certain restrictions imposed on the parameters contained in the integrand). Asymptotic formulas are obtained for a free surface and the interface.

Numerical simulation of directional radiation from tsunami source

Urban, N.A.

Solution of the problem of directional radiation is considered in terms of linear theory of long waves. For an instantaneous -dislocation-type model of the source, which is represented by a differentiated source, we have solved the problem of extremal radiation into a given angle and evaluated maximum and minimum energies radiated into a certain angle. Density distribution of the energy radiated by the source is studied as a function of the direction concerned.

Continuation of the wave field for determination of tsunami source

Kaistrenko, V.M.

The findings on the problem of tsunami source reconstruction are presented. It is shown that the eigenfunctions (modes) exhibit the property of uniqueness of complete or partial continuation: being known in a part of the ocean, they can be reconstructed for the whole of greater part of the ocean. Accurate conditions are established under which the field of long gravitational waves can be continued uniquely with due account of rotation and variable relief of the bottom. Hence, it is proved that basing on the wave field recordings made in a limited portion of the ocean we can reconstruct the initial perturbed state of the water layer in the source zone.

Tsunami wave diffraction by the submarine shore slope of a circular island

Selezov, I.T.; Tkachenko, V.A.; Yakovlev, V.V.

The problem of diffraction of a cylindrical transient wave by the island shelf of variable depths has been solved using the numerical - analytic method. The effect of the bottom topography upon the diffraction nature is considered.

Application of numerical methods to the problem of tsunami short-time prediction

Marchuk, A.G.

The problem of determining the time of tsunami propagation from

the source in the open ocean to a point on the shore is solved. In a general case, for arbitrarily distributed depths, the problem was not resolved. Its solution has been obtained for an inclined bottom. Methods are suggested for constructing maps which will make it easy to determine the time of tsunami arrival at points of interest to us from a known tsunami source location.

Approximate boundary conditions at the water edge, convenient for numerical calculation of tsunami inundation

Mazova, R. Kh.

Approximate boundary conditions at the water edge are suggested, which permit the use of methods involved in calculations of the waves in the open ocean to calculate the run-up of nonbreaking waves. A shift in the boundary conditions on the shelf will cause a 10-20% inaccuracy in the determination of an upheaval, which is quite acceptable from the standpoint of tsunamizonation. The suggested approximate boundary conditions will facilitate the application of conventional methods for tsunami calculation.

Effect of the source parameters upon tsunami characteristics

Korolev, Yu. P.; Poplavsky, A.A.

Wave height versus source parameters is studied in terms of the Cauchy-Poisson problem. It is shown that for sources of arbitrary forms but of constant energies the dependence of the excited wave amplitude upon the source linear dimensions and time of action has an extremum. As a result, there are sources with unfavourable dimensions and time of action, that generate waves of maximum heights at a fixed distance.

Study of the tsunami dynamic characteristics during run-up

Simonov, K.V.; Poplavsky, A.A.

Basing on numerical simulation, we study the dynamic characteristics of a stream resulting from tsunami run-up. Calculations of the front and stream velocities make it possible to estimate the instant of wave breaking on the shore. The horizontal distance of inundation and the dynamic characteristics of the wave at the water edge are found to depend nonmonotonically upon the length of an unperturbed wave. Two possible interpretations of this effect are outlined.

Some results of physical modelling of the tsunami excitation and propagation processes

Basov, B.I., et. al.

A dimensional analysis is carried out to model the processes of tsunami excitation and propagation. The conditions under which a wave tank proves suitable for modelling the processes in question are established. The results of model seismogram processing by the method of spectral-time analysis are presented. A conclusion is drawn that an explosion-type wave generator is fairly promising.

Microzonation of the Kasatka bay with respect to tsunami

Vasil'ev, A.A.

The main results of numerical simulation of the tsunami propagation and transformation in the Kasatka Bay region with due reference to the actual depth distribution are reported. Basic to the method employed is an integral model of nonlinear equations for shallow water allowing for the Coriolis parameter, friction, and other factors, which is realized by means of an explicit scheme of the second-order of accuracy on an intermittent net by recursion. It is for the first time that the process of tsunami propagation from the source to a ten-meter isobath is reproduced within the frame of a two-dimensional problem for so small regions under study.

Frequency properties of the Kuril shelf

Fain, I.V.

Basing on a simple linear theory of stationary long waves propagating along a straight-line shore in a homogeneous ocean with a cylindrical shelf, we have calculated the gains for normally incident Poincare waves and the dispersion relations of edge waves over a frequency range $0-3h^{-1}$ for the Pacific water area adjacent to the Kuril Islands. Regions possessing certain frequency properties are separated.

Estimation of tsunami risk of submarine earthquakes on the basis of spectral characteristics of Rayleigh waves

Gusyakov, V.K.

We have studied the prognostic properties of Rayleigh waves by comparing their spectral characteristics for a number of violent submarine earthquakes, some of which gave rise to tsunami. Our starting information was provided by numbered long-period seismograms

of these earthquakes. The amplitude spectra of Rayleigh waves and the diagrams obtained from a spectral-time analysis of the recordings are examined.

Probability for tsunamigenity of an earthquake depending upon the source parameters

Vyalykh, V.F.; Ivaschenko, A.I.

The statistics for estimating tsunami probability on the basis of a set of earthquake parameters is presented. The main point of this statistics is illustrated by the efforts involving real and synthetic catalogues of earthquakes.

Tsunami Research in the USSR, 1979-1982

A report on Tsunami Studies in the USSR in 1979-1982 was presented to the International Union of Geodesy and Geophysics and was published in Moscow in late 1983. A copy was recently received at the ITIC.

The report contains a bibliography compiled by V. A. Bernstein, K.V. Simonov and M.S. Sladkevich and a summary of research prepared by the Editor-in-Chief, S. L. Soloviev and editors A. I. Ivaschenko and A. A. Poplavsky. The report summarizes the contributions of the Academy of Sciences of the USSR, and its different Institutes as well as the contributions of Universities and other governmental organizations. Copies of the report can be obtained by writing directly to the editors or to the IUGG. The following is a brief summary of the research studies that were completed in the USSR in 1979-1982.

Organization and Major Trends of Researches on the Tsunami Problem in the USSR in 1979-1982.

As in the preceeding three years the tsunami phenomenon and associated practical aspects were studied in different scientific institutions. Coordination of the researches was performed by the Tsunami Committee of the Scientific Council on the problem "Study of Oceans and Seas and Use of their Resources" of the State Committee on Science and Technology (SCST) of the USSR. Corresponding member of the Academy of Sciences of the USSR S.L. Soloviev is the President of the Tsunami Committee. Proceedings of the Committee meetings have been published.

The most valuable contributions to the tsunami problem study were made by the following organizations of:

The Academy of Sciences of the USSR: the Institute of Oceanology (IO), Institute of Physics of the Earth (IPE), Institute of the Problems of Control (Automatics and Telemechanics) (IAT), Moscow; Institute of APplied Physics (IAP), Gorky;

The Siberia Branch (SB) of the Academy of Sciences of the USSR: Computer Centre (CC), Institute of Mathematics (IM), Institute of Theoretical and Applied Mechanics (ITAM), Novesibirsk;

The Far East Science Centre (FESC) of the Academy of Sciences of the USSR: Sakhalin Complex Scientific Research Institute (SCSRI), Yuzhno-Sakhalinsk;

The Academy of Sciences of the Ukrainian SSR (AS,UKR.SSR): Marine Hydrophysical Institute (MHI), Sevastopol; Institute of Hydromechanics (IHM), Kiev;

The State Committee on Hydrometeorology and Control of Natural Environment (SCHCNE) of the USSR: Far East Scientific Research Institute (FESRI), Vladivostok; Instrument Engineering Scientific Research Institute (IESRI), Moscow;

The Ministry of Higher and Special Secondary Education of the USSR, RSFSR and Byelorussian SSR: Byelorussian Polytechnical Institute (BPI), Minsk; Far East State University (FESU), Vladivostok; Irkutsk State University (ISU), Irkutsk, Leningrad Hydrometeorological Institute (LHMI), Leningrad; Scientific Research Radiophysical Institute (SRRPI), Gorky; Gorky Polytechnical Institute (GPI), Gorky, Moscow State University (MSU), Moscow; Moscow Engineering Institute (MEI), Moscow; Rostov State University (RSU), Rostov-on-Don.

According to a special governmental decree adopted in 1980, the main objective of tsunami studies during the past three years was to provide scientific, methodical and technical basis to create a unified automated system (UAS) for observation of tsunami generation and propagation, and tsunami warning in the USSR Far East coastal regions (SCSRI, CC IAT, IPE, BPI, FESRI, IESRI).

Studies were continued on tsunami generation mechanisms (IO, SCSRI, CC, ITAM, SRRPI, RSU) and tsunami propagation in the ocean by means of analytical (IM, IAP, GPI, SCSRI) and numerical-analytical (CC, ITAM, LHMI, IHM) methods, and those on secondary physical fields associated with tsunami (SRRPI, IO, FESU), transformations of tsunami waves at shallow-water depths and during tsunami run-up onto the coast by means of analytical (GPI, IAP) and numerical (LHMI, MEI) methods.

Tsunami wave entering real harbours and bays of different types was modeled physically (MSU), principles and schemes and of tsunammi hazard zoning were developed (LHMI, IO, SCSRI).

There has been progress in experimental studies that yielded records of tsunamis of small intensity made in the open ocean and on near-island shelf (SCSRI).

Summaries of theoretical results, semi-analytical emthods of calculations and mathematical modeling results in the tsunami

problem have been published.

The Tsunami Warning Service has been operative in the Sakhlin and Kamchatka regions.

PACIFIC TSUNAMI WARNING CENTER

Seismic Summary (June 1, 1984 to Press Time)

EVENT NO	EVENT	LOCATION	ACTION TAKEN
1984-7	May 26	South Pacific Ridge	No Earthquake
	0005 (UT)	57.5S	Information Bulletin
(PTWC)	6.5	133.0W	issued.
1984-8	May 30	New Britain	No Earthquake
	0750 (UT)	4.6S	Information Bulletin
(PTWC)	6.5	152.4E	issued.
1984-9	Jul 5	Soloman Sea	Earthquake Informa-
	0522 (UT)	6.1S	tion Bulletin issued.
(PTWC)	6.6	154.5E	
1984-10	Aug 6	Kyushu, Southern	Earthquake Informa-
	1907 (UT)	32.2N	tion Bulletin issued.
(PTWC)	6.8	171.3E	
1984-11	Sept 10	Mendocino Ridge West of Eureka	No Earthquake Information Bulletin
	0314 (UT)	40.3N	issued.
(PTWC)	6.5	126.8W	
1984-12	Sept 18	Honshu, Japan	Earthquake Informa-
	1703 (UT)	33.9N	tion Bulletin Issued.
(PTWC)	6.9	141.5E	
1984-13	Nov 1	Mid-Atlantic Ridge	No Earthquake
	0449 (UT)	8.9N	Information Bulletin
(PTWC)	6.7	38.6W	issued.
1984-14	Nov 15	East of New Caledonia	Earthquake Informa-
	0246	22.1S	tion Bulletin issued.
(PTWC)	6.7	170.9E	
1984-15	Nov 17	Sumatra, Indonesia	No Earthquake
	0650	2.1N	Information Bulletin
(PTWC)	7.2	96.5E	issued.
1984-16	Nov 20	Southern Mindanao Philippines	Earthquake Informa- tion Bulletin issued.
	0815	5.8N	
(PTWC)	7.1	125.5E	

SPECIAL ANNOUNCEMENT

T S U N A M I 8 5

Three International Tsunami Meetings:

WORKSHOP on the Technical Aspects of Tsunami Analyses, Prediction, and Communications

ITSU-X the Tenth Meeting of the International Co-ordination Group for the Tsunami Warning System in the Pacific

ITS 85 The International Tsunami Symposium of the Tsunami Commission of the International Union of Geodesy and Geophysics

will be held in Canada at the Institute of Ocean Sciences, Sidney, B.C. and the Empress Hotel, Victoria, B.C., July 29 to August 9, 1985.

Scientific and technical sessions will bring together many of the world's leading tsunamists. Social and recreational programs are being arranged for accompanying persons and participants. A post-symposium tour to Port Alberni, site of tsunamiinundation of 1964, and the outer coast is planned.

Information:

If you have not already applied to be on the mailing list for information and brochure, and received acknowledgement, please write to:

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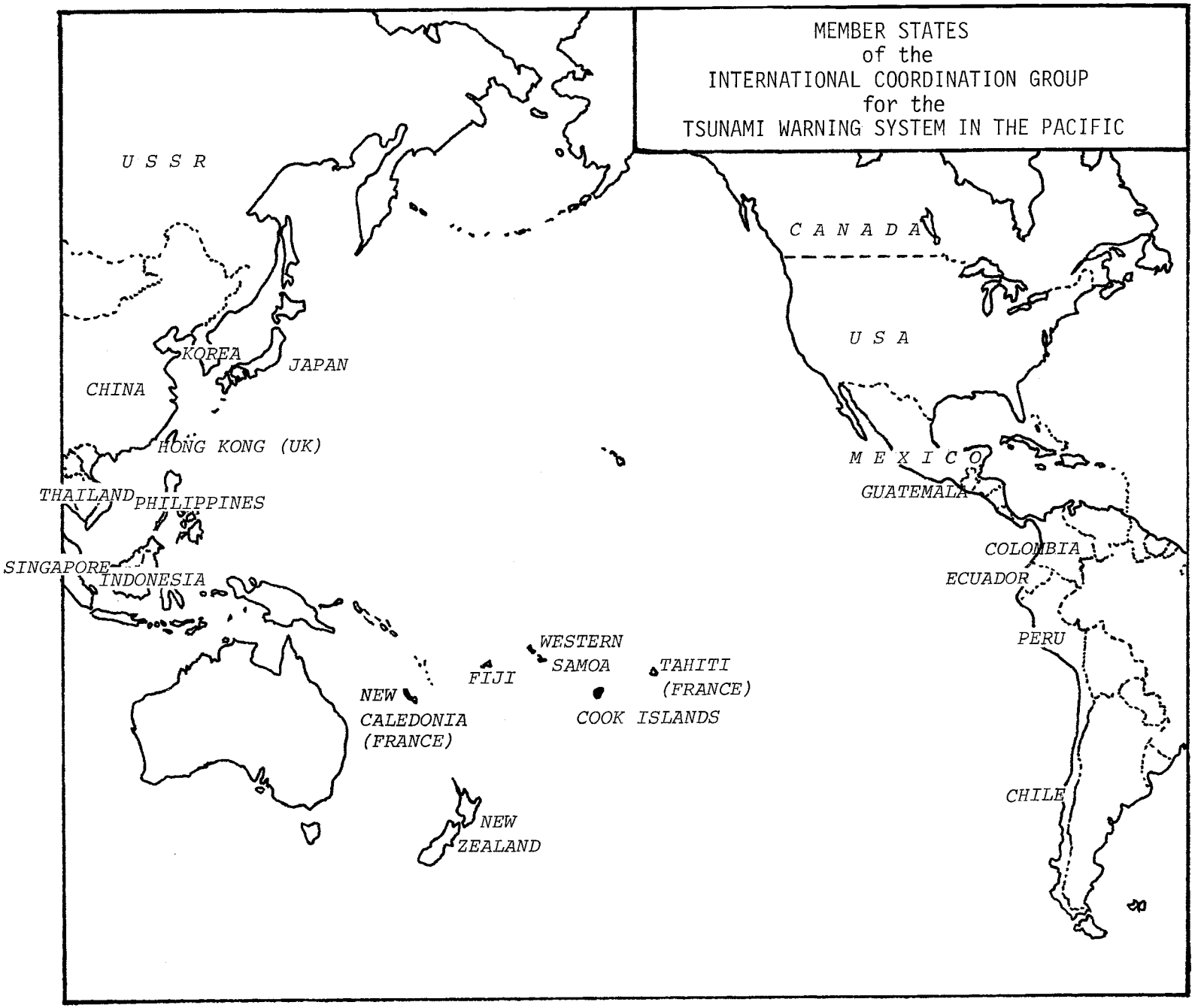
Mele Kalikimaka
Merry Christmas

and a

Hauoli Makahiki Hou
Happy New Year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